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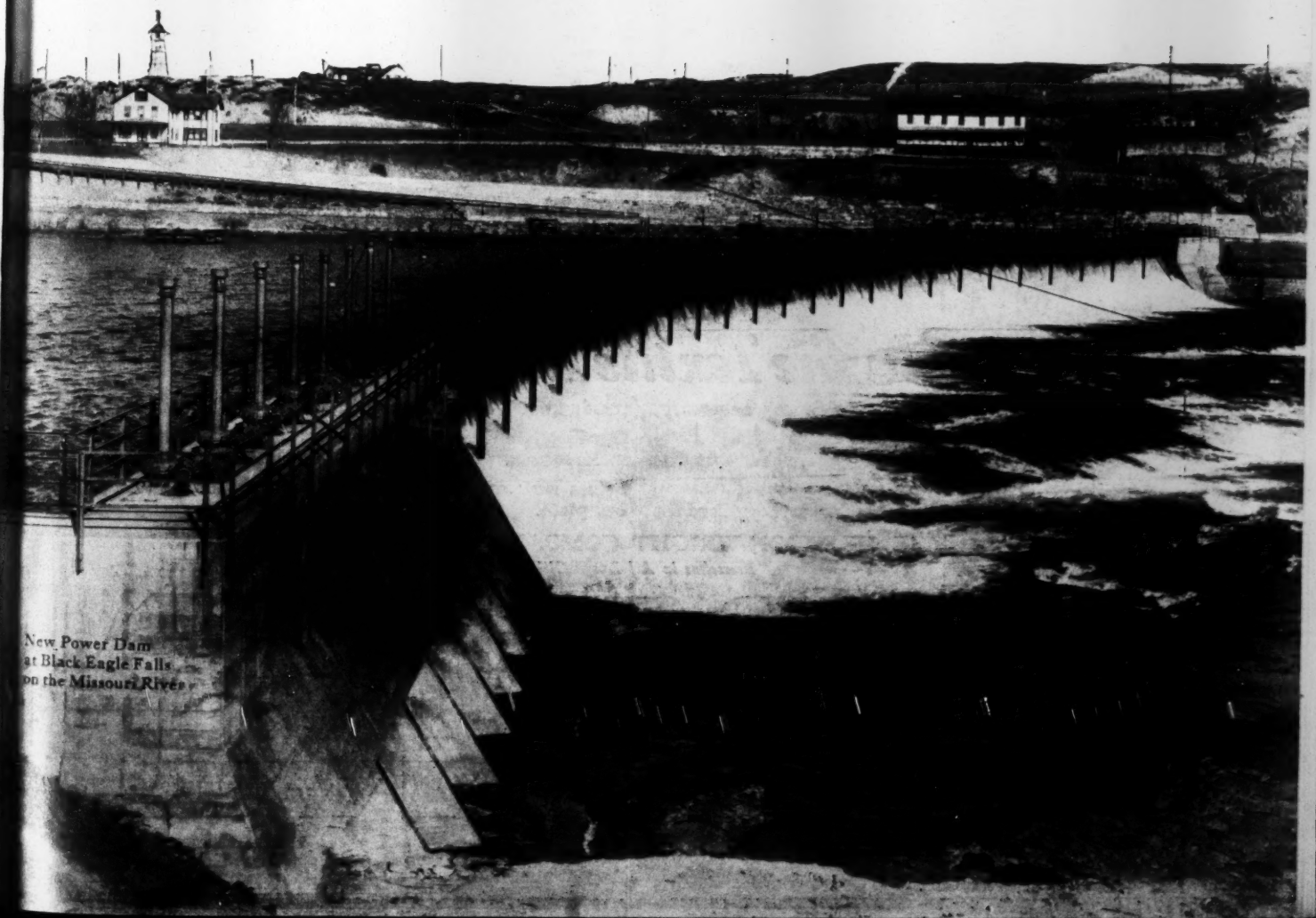
Engineering News-Record

Hydro-Electric Plant in Missouri River Redeveloped After 37 Years of Service

Well-Point Drainage Simplifies Construction of Sewage-Works at Cleveland



New Power Dam at Black Eagle Falls on the Missouri River

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Engineering News-Record

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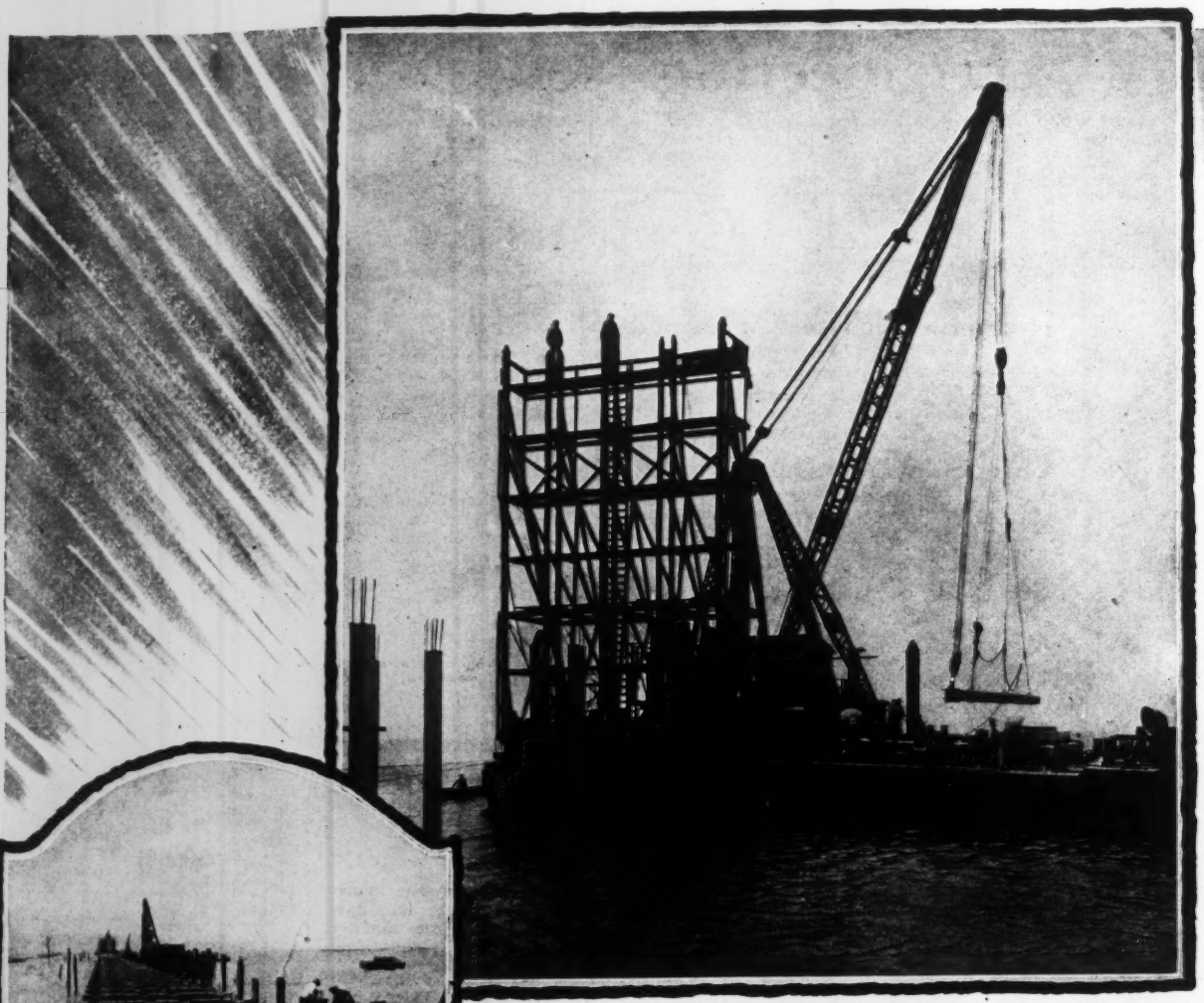

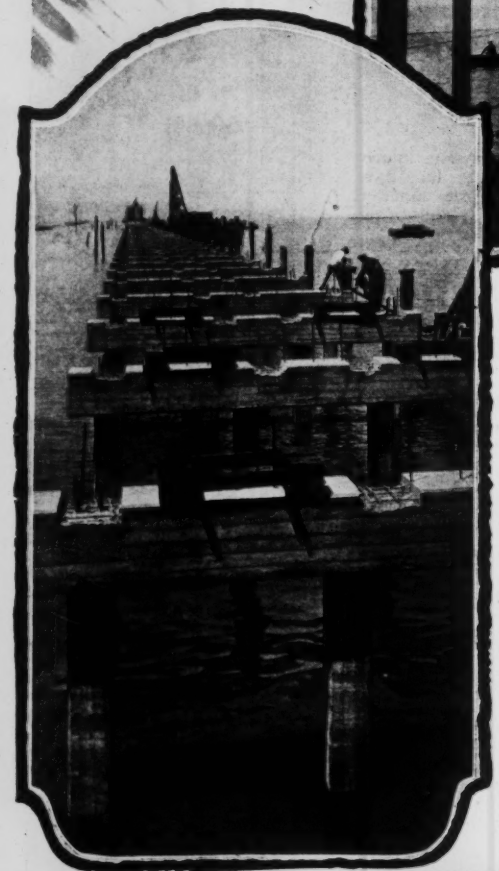

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Owners: San Francisco Bay Toll Bridge Company

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This reinforced concrete structure connects San Mateo on the west side of San Francisco Bay with Mt. Eden on the East—37,500 lineal feet from the concrete piles at one end to those at the other (over 60,000 lineal feet, including approaches) requiring:

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1,216	bays of precast concrete slabs.
72,000	lineal feet of concrete handrail and curbing.
75,000	cubic yards of concrete.
10,000	tons of reinforcing steel.
3,500,000	square feet of forms.

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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

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Volume 101 NEW YORK, JULY 12, 1928 Number 2

Countrywide Service

SOME years ago, when the American Society of Civil Engineers changed from the system of semi-annual to that of quarterly meetings, the wisdom of wide geographical distribution of meeting places had not yet been demonstrated. Since then the plan has developed into an outstanding success. We think it is not too much to say that today the resulting countrywide extension of the society's service is a decided factor in its growing strength. The matter at issue is not merely that of the distance which separates different parts of our extensive country, but to a more important degree the essential difference of their problems—the local color of engineering. However much or little the general theme of dams, or of canals, or of bridges, may mean to a given region, it takes on a quite different meaning when translated into terms of the specific dam, canal or bridge in which the local community is interested at the time. Thus to translate a local engineering difficulty from general terms into the language of the local requirements has a value that is hard to over-estimate. The society's meeting plan, in helping to accomplish this effect, is thus a constructive force both for the society and for the public which it serves. It is a means for extending the best influences of engineering over the full extent of the country.

Lower Air Rates

AFTER ten years of successful operation the air mail service of the government announces a reduction in rates from 10 cents to 5 cents per ounce. In many ways this announcement represents the most significant step that has yet been taken to develop the full potentiality of fast mail transportation. The new rate will place the cost of air mail service within the reach of all, certainly making it available to every business. Thus the government is taking advantage of the lesson learned by private business, namely that mass production means lower costs, or rather in this particular case that lower costs will result in a greatly increased volume of mail. Even on the basis of the old high rate the growth of the air mail service has been phenomenal. First operated by government planes, it became profitable enough that all routes are now flown under contract by private air transport concerns. In May, 199,284 lb. of mail were carried, representing an increase of 28,000 lb. over the preceding month. With the new rate the monthly increases should mount substantially higher. The great difficulty has been that the average load weighed 175 lb. while the cost of transportation was little less than for a load of 1,000 lb. This difficulty should be relieved by the new rates, since they are sure to increase the average load per plane. Just as important as the considerations directly affecting the air mail is the fact that air carriage of freight and passengers will be furthered by increased air-mindedness on the part of the public. Perhaps a substantial reduction in air transport rates for passengers and freight would be met with astonishing results. At least it seems worth trying.

Stimulating Competition

ONLY a few months ago the Interstate Commerce Commission's decision in the Piedmont & Northern case made it look as though the commission was firmly convinced that competitive railway construction is undesirable. But within recent weeks the commission has again upset that view by its decision in the Pittsburgh & West Virginia Railway case. In the latter, the commission authorized the railway to build a new line in the highly competitive territory around Pittsburgh. This is an encouraging prospect, particularly in view of the Piedmont & Northern case, because it confirms the belief that something other than a desire to throttle competitive railway construction influenced the commission in forming its decision in that case. Competition among railways is essential to the maintenance of good service and reasonable rates. The framers of the Transportation Act recognized that fact when they wrote into it special provisions for its maintenance. Of course too much competition can be destructive of good service, by impoverishing the railways, but there appears to be a tendency on the part of the railways to throttle it under the guise of obtaining economies through consolidating separate railway lines into single systems. The proposed Great Northern-Northern Pacific merger is an instance. The commission must decide what economies in that consolidation will offset the loss of desirable competition. Its decision in the Pittsburgh & West Virginia case makes it appear that it still favors the maximum amount of competition in railway operation, which was not at all evident in the Piedmont & Northern decision.

Talking It Over

WHEN unhealthy relations come to exist between two groups of men, one of the shortest roads to a cure is to talk the trouble over. The recently begun meetings between contractors and equipment men on the subject of unsound credit practices are a promising use of this procedure. Unsound credits born of blind competition are not constructive, but on the contrary injure both machine-builder and contractor. They transform normal commerce and industry into speculation, a process which, once started, tends to draw into its whirlpool the entire field, the sound as well as the speculative element, with increasingly harmful results. Purchasing by contractors has gone far in this process of involvement. The time is therefore appropriate for a revision of practice, in the general interest of the art of construction. The conferences begun by the Associated General Contractors, fortunately, drew a prompt and favorable participation

by the makers of equipment. Study of the problem doubtless will take some time before a lasting solution is reached, but there is every promise that the work will be carried through. With the co-operation of both parties, equally interested, an adjustment adapted to the needs of both can hardly fail to be found.

Mississippi Problems

WITH the gradual removal of the Mississippi River flood control from the political arena, it can be recognized more plainly that intensive and many-sided research will be required before the problem is within reach of solution. This means a complete departure from the practices of the past. For a hundred years or more the river has been studied by the method of contemplation only; the great resources of energy and money necessary for an attack upon its problems by experiment or by actual trial have never been available. Levee construction was resorted to as the easiest and most obvious means of combating high-water stages, and similarly all details of the river work were evolved, so to say, as emergency measures, controlled by dictates of time or economy. Hence there has never been so much as a pretense of holding the river in a stabilized condition. But the present enterprise of flood protection on a grand scale calls for this stabilization as a first and imperative requirement; yet the task of bringing about stabilization of the shifting, sinuous low-water channel, with its broken and variable grade line, as well as of the much broader but straighter flood channel between the levees, equally changeable in slope, is one of which practically nothing is yet known. Accordingly, whatever can be done at this time to fix upon an engineering solution of the Mississippi flood problem is bound to be limited to outlining a few initial parts of the work. It cannot forecast the final plan, and indeed, because of the thoroughgoing lack of knowledge of the problem, any plan now laid down is humanly certain to prove a failure. A year has passed since the great flood. Up to the present nothing has become known of any intention on the part of the authorities to study the hydraulics or the soil resistance of the river. It has become clear, however, that the whole future of the Mississippi River work rests on research and study.

Engineering for the Layman

WHILE the daily press as a whole pays little attention to technical matters or developments, and then generally in a casual or even semi-humorous and often inaccurate manner, there are occasional exceptions which illustrate the possibility of informing the public on matters of interest or importance. These exceptions usually result from co-operation with engineers. Such an instance comes to notice in connection with the recent opening of the new sewage-works at Bloomington, Ill., when the local *Pantagraph* published not only the engineer's technical description of the works but also a series of articles on "Sewage-Plant Operation." In these articles the striking feature was that the subject was handled in such style and language as to be interesting to the general reader, instead of being a dry explanation of operations more or less mysterious to the layman. It is highly probable that to a large proportion of readers this subject—handled in this way—was as interesting as the detailed information on sports, crime and politics. As an example of the style mentioned the following quotation is illuminating:

> Some of the [dosing] tanks will be filling, some nearly empty, some almost full. If the visitor waits awhile an open crook in a pipe at the edge of the water in one of the tanks will suddenly snort and begin spitting water. Some place in the tank there will be a great sigh and the sound of a tremendous suction. The level of the water will begin to drop.
>
> At this point it is time for the spectator to look off at the adjacent sprinkling filter beds. A half of the 2½ acres of beds of crushed rock will suddenly sprout into hundreds of crystal sprays. They will look like a pretty flower bed, all the sprays set out in check-rows like corn.
>
> . . . . . .
>
> At intervals, which depend upon the rate of sewage flow through the plant, all the nozzles that are set at the surface of the crushed rock over these beds will sprout into glistening fountains of equal height and equal width. . . . When the plant will have been run for a time, a coating of jelly-like matter will gather upon the stones and in this millions of bacteria will live. As the water will trickle down through these stones and over this jelly the bacteria will attack the objectionable substances in solution in the water and change them into nitrates and nitrites.
>
> . . . . . .
>
> It is evident that the sprinkling filter beds would become clogged up in time with gelatinous matter if there were not a means by which it ridded itself of the gelatine. This clearing is done automatically by the bacterial action in the bed. When the gelatinous matter becomes too heavy it sloughs off, usually much of it at the same time. The chief function of the secondary settling tank is to clear the water of this gelatinous matter.

Ability to Repay

HOW much longer the Federal government is to continue utilizing the reclamation fund to develop land at a loss is a question deserving of more than casual attention. Secretary Work having resigned, it will be one of the most immediate questions before the new Secretary of the Interior. The time is at hand when a sound, businesslike policy of administering the reclamation laws needs to be set up—a policy which will truly help instead of bringing misfortune to the settler, and will apply the public money usefully instead of wasting it.

Five or six new projects were authorized by Congress at its last session. Existing law requires that new irrigation works, as well as extensions and betterments, shall be built only if they are able to repay their cost. Heretofore this requirement has been interpreted in a spirit of buoyant optimism, the interested pleas of land speculators and the impatient demands of Congressmen being taken as virtual assurances of repayment. But now that Congress itself has certified to the inability of collecting the construction cost even on a most prosperous project—as it did recently in the Rio Grande relief act—it is evident that such empty assurances must be ignored and only solid business forecasts be depended upon for approval of the soundness of new expenditures. If this is done, not one of the new projects will be built for years—unless a way is found for avoiding the losses so uniformly experienced until now.

On many of the existing federal projects, farming has gone downhill to about the last stage. Not a few settlers have lost their farms to mortgage holders. Tenantry has become the order of the day. Efforts at colonization have succeeded only with improved property. When a farm has a house, a well, farm buildings and fences, and the land is cleared and leveled, it can be sold—not otherwise. Conquering the raw land is not an economic possibility under present conditions, and those who come to seek a farm home on the projects know this. The few who have the courage to make their homes on raw

land do not have enough money; $2,500 or so is too little to meet the lean period of preparation. If they try borrowing, they find that lenders are few and interest rates usurious because of the hazard of the investment.

Yet unless someone farms the land, it lies fallow, adjacent farmers on the project eventually are forced to the wall, and repayment of cost to the government becomes impossible. Then follows agitation for relief—more truthfully stated, for the practical cancellation of the construction debt. But even though such relief is granted it does not save the settler, for the water cost is not the major expense, and in many cases it is doubtful whether certain projects would be settled even though the government gave the project to the water users. In case of the Milk River project, for instance, it is said that nothing will be accomplished by writing off construction costs because none have been paid, and without more good farmers none will be paid.

Belle Fourche project, in South Dakota, added 27 settlers in 1927, all of them on farms with houses; then settlement stopped, for no one would take a farm that lacked buildings. So long as the 400 farms now idle remain without resident cultivators this project cannot be a success. On the Lower Yellowstone project, in Montana, no difficulty was found last year in securing settlers for the 24 unoccupied farms that had houses, but none others could be sold, and less than a third of the 47,339 acres are now irrigated. At Milk River, only one-fifth of the 76,390 acres of the Malta and Glasgow divisions were irrigated last year. Here as well as elsewhere, it was proved that homeseekers will not buy unimproved land and so development is at a standstill. And the same is true of other projects—Willwood, Riverton, Orchard Mesa.

These are typical instances of economic failure to date. Yet the projects named did not cost half as much per acre as the newly authorized projects. Is there any possible chance then that these will be other than complete failures? Unless conditions can be created that will attract pioneering settlers who can succeed, the half dozen authorized projects and the forty private projects now clamoring for federal attention would better remain unreclaimed sagebrush desert.

What can be done? Dr. Elwood Mead, the federal commissioner of reclamation, has long held that this country will have to come to the point of loaning money to supplement the settlers' capital for permanent improvements, just as has every other country. If millions are to be appropriated for building irrigation canals, he believes it good business to appropriate a small fraction of that sum for improvements, in order to make possible the return of those millions. Building houses and leveling the land will, he holds, enable the projects to be settled promptly and establish profitable farm operation.

It is not likely that such practice, often denounced as "paternalism," will be accepted offhand by Eastern politicians. Nor is it easy to meet the argument that the government cannot make its collections in any event, unless there is a hard-boiled local agency to enforce foreclosure on the improvident and incompetent. Some careful observers, moreover, hold that the responsibility of making collections should be placed upon the states, not upon the federal government; but not one of the Western states has yet been willing to take over this function, and Congress, whose policies in reclamation have ever been dictated by the West, has not insisted that they do so.

The present condition gives eloquent testimony of the failure of existing policies. Great areas of land, completely equipped with irrigation works, are still unoccupied. This unused acreage is largely to blame for the continued entreaties for relief on the part of those who are using that land and have to bear the annual operating cost chargeable to both used and unused land. If the idle farms can be settled by the expedient of converting them into going enterprises, it does seem that such a plan is worth trying out. Anything that will tend to make existing projects successful is a worth-while experiment. Money devoted to this purpose would be applied more usefully than the millions now being poured out in the construction of new projects of doubtful success. And the experiences obtained from such improved administration of the older projects may show the way to making even the high-cost new projects solvent enterprises.

Another Bogey Gone

THE passing of prejudices against new agents or methods is sometimes as notable as the advances themselves. Forty years ago, when the use of sulphate of alumina made possible the advent of mechanical or rapid filtration of water, there was strong opposition to putting any chemical reagent into drinking water. Many a battle royal, waged in the next two decades between the advocates of slow and rapid or mechanical filtration, centered largely in arguments on the harmfulness of alum, and whether in fact any alum remained after completion of the chemical reaction that forms the hydrate of alumina floc for precipitation and clarification. Time and experience acting on millions of users of water subjected to mechanical filtration won the day, so that now practically all filtered water has been treated with a coagulant—and this is true even of the relatively small amount of water that passes through slow sand filters.

With the passing of the prejudice against alum have come not only great improvements in dosing methods and control, essential to its use on an ever increasing scale, but also the manufacture of the coagulant by the city or the water company, at the filtration plant. This manufacture began a dozen years ago and soon extended to as many cities, alum cake being produced from bauxite, a "natural earth" high in alumina, by introducing sulphuric acid. Later, the process was stopped before the crystallization stage was reached, and the syrup of alum stored in tanks for direct use, thereby eliminating the extra labor of breaking, grinding and dissolving the alum cake. The entire process, as practiced at Baltimore, is described on p. 65 of this issue, together with other interesting details of chemical handling and control.

It is interesting to speculate on how the old-time opponents of mechanical filtration would have protested against having a chemical produced by "boiling" bauxite with "brimstone sulphuric acid" applied to their drinking water; all the more interesting when it is stated that alum similarly produced is used at the new rapid filtration plant of Washington, D. C., a city where a quarter century ago strongly organized opposition to mechanical filters (because alum would be used with them) contributed materially to the adoption of slow sand filters when the first filtration plant was decided on. This, too, for a water very turbid at times. Subsequently, alum was used in the Washington settling reservoirs. No dire results following, and a new generation having come on the stage, mechanical filtration, with alum as a coagulant, was adopted. Thus does prejudice disappear and the world advance.

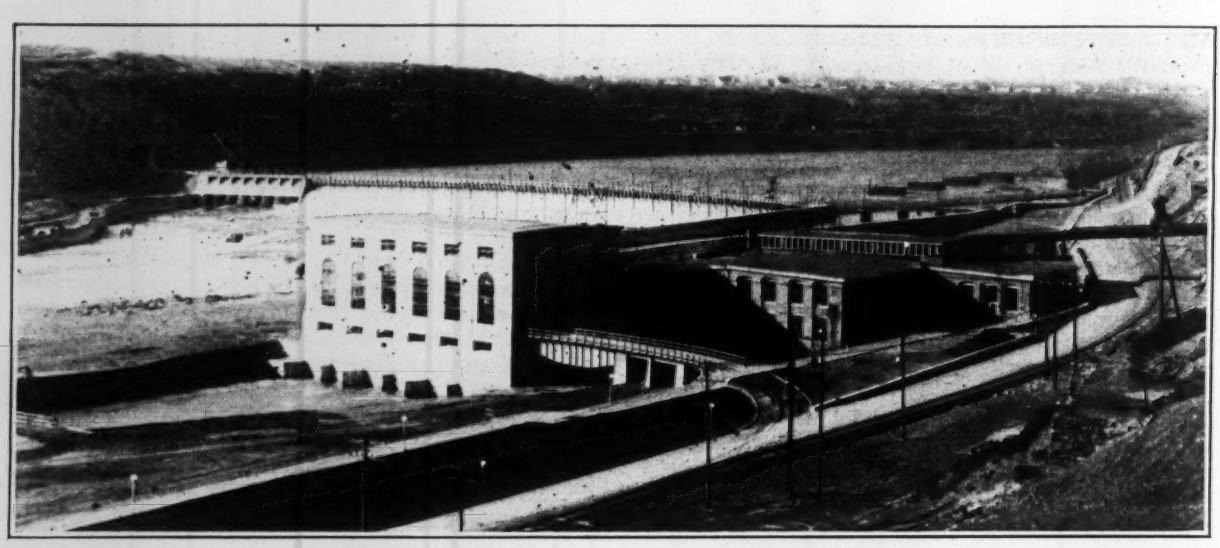


Fig. 1—New Hydro-Electric Plant at Black Eagle Falls

Hydro-Electric Redevelopment on Missouri River

Dam and Power Plant at Black Eagle Falls, Mont., Rebuilt After 37 Years' Service for Modernizing and Development of More Power—Curved Concrete Dam

By R. A. Moncrieff

Charles T. Main, Inc., Engineers, Great Falls, Mont.

In THE 48-mile stretch of the Missouri River between Great Falls and Fort Benton, Mont., there is a total drop of 695 ft., of which 485 ft. occurs in the first 15 miles and is to a great extent concentrated in six falls, which are collectively known as the Great Falls of the Missouri River. Since they assume the form of cascades, with considerable distance between the brink and foot of the falls, no exact height can be ascribed, but their location and height are about as follows, the distances being measured from the Great Northern Railway bridge at Great Falls, Mont.: 22 ft. drop at Black Eagle Falls, 16,000 ft. below the bridge; 14 ft. at Coulters Falls, 30,700 ft.; 47 ft. at Rainbow Falls, 32,000 ft.; 29 ft. at Horseshoe Falls, 34,500 ft.; 77 ft. at Great Falls, 57,000 ft., and 25 ft. at Sheep Creek Falls, 73,000 ft. There are now three hydro-electric developments: at Black Eagle Falls, 18,000 kw. under 51-ft. gross head; at Rainbow Falls, 35,000 kw., 114-ft. head; and at Great Falls, 60,000 kw. under 154-ft. gross head. There are also two undeveloped sites, one under 68-ft. head between Rainbow Falls and Great Falls and the other under 72-ft. head at Sheep Creek Falls. The new Black Eagle plant is shown in the illustrations.

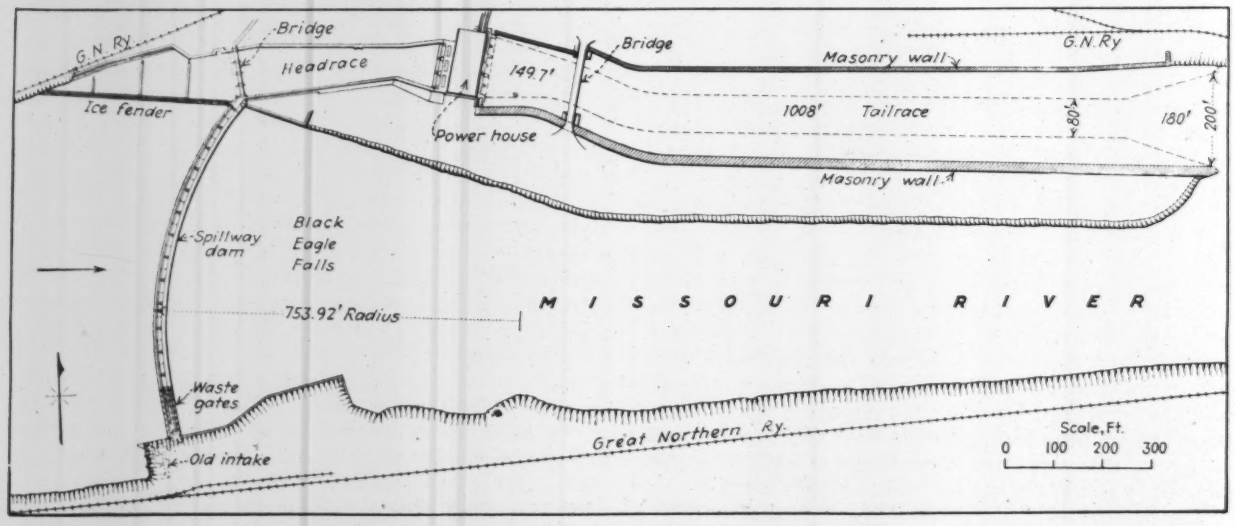


FIG. 2—GENERAL LAYOUT OF POWER DEVELOPMENT

In these figures the height given in each case is that from the crest to the toe of the actual fall prior to development, while the developed head is the height from the flashboard crest of the dam to the tailwater. In practically every case the major part of the developed head is due to the height of the dam built at the crest of the falls, with an additional 4 to 6 ft. gained by discharging the tailwater some distance downstream from the foot of the falls. For instance, in the case of Black Eagle, the height of the dam is 25 ft., the depth of the falls 22 ft., and the gain in the tailrace 4 ft., making a total gross developed head of 51 ft.

In 1890 J. T. Fanning and Henry A. Herrick, engineers, built at Black Eagle Falls the first water-power plant in Montana, developing 2,600 hp. under 40-ft. head on the north side of the river for the reduction works of the Boston & Montana Consolidated Copper & Silver Mining Company; and 1,060 hp., under 40-ft. head, on the south side for the Boston & Great Falls Electric Light & Power Company. In 1894 the Great Falls Water Power & Townsite Company built a second power house on the south side with a 54-in. horizontal waterwheel transmitting power by a single wire-rope drive 1,800 ft. to the Royal Milling Company's plant. The total installed capacity was then about 2,600 hp. on each side. In 1913 the Montana Power Company installed two 2,700-hp. wheels on the south side, abandoning the existing machinery on that side and making the total installed capacity 8,000 hp.

In 1926 Charles T. Main, Inc., engineers, Boston, Mass., in consultation with the engineers of the Montana Power Company, proposed the redevelopment of this site and the abandonment of all existing plant in order to meet the growth of the city of Great Falls and the increasing demand for power by the reduction works of the Anaconda Copper Mining Company. This improvement, completed in 1927, gives 27,000 hp. under 50-ft. head. The minimum average flow, which originally was 2,300 sec.-ft., is now 4,600 sec.-ft., due to engineering projects above Black Eagle Falls, having an available storage of 508,500 acre-ft.

Original Development—The development of 1891 (see *Transactions*, American Society of Civil Engineers, Vol. 27, July, 1892) consisted of a timber crib rock-filled dam, 746 ft. long, 14 ft. high and 57 ft. wide at the base, with the crest 10 ft. from the upstream face and the deck sloping about 3 on 10 to the downstream toe and to the vertical upstream face of the dam, which was about 9 ft. high. Cribs 8 ft. square were built of 12x12-in. timbers laid horizontally, and the deck had two layers of similar timbers at right angles, the top layer being parallel with the flow. Both abutments were of cut stone. At the north end three gate openings discharged into the headrace, each having two timber gates, while two waste gates between the canal and the dam discharged into the river. All gates were 7 ft. 3 in. wide and 10 ft. 10 in. high, with double timber stems and cast-iron racks for operation. At the south end were six gates in three compartments closed at the downstream end with a masonry wall through which the penstocks were taken.

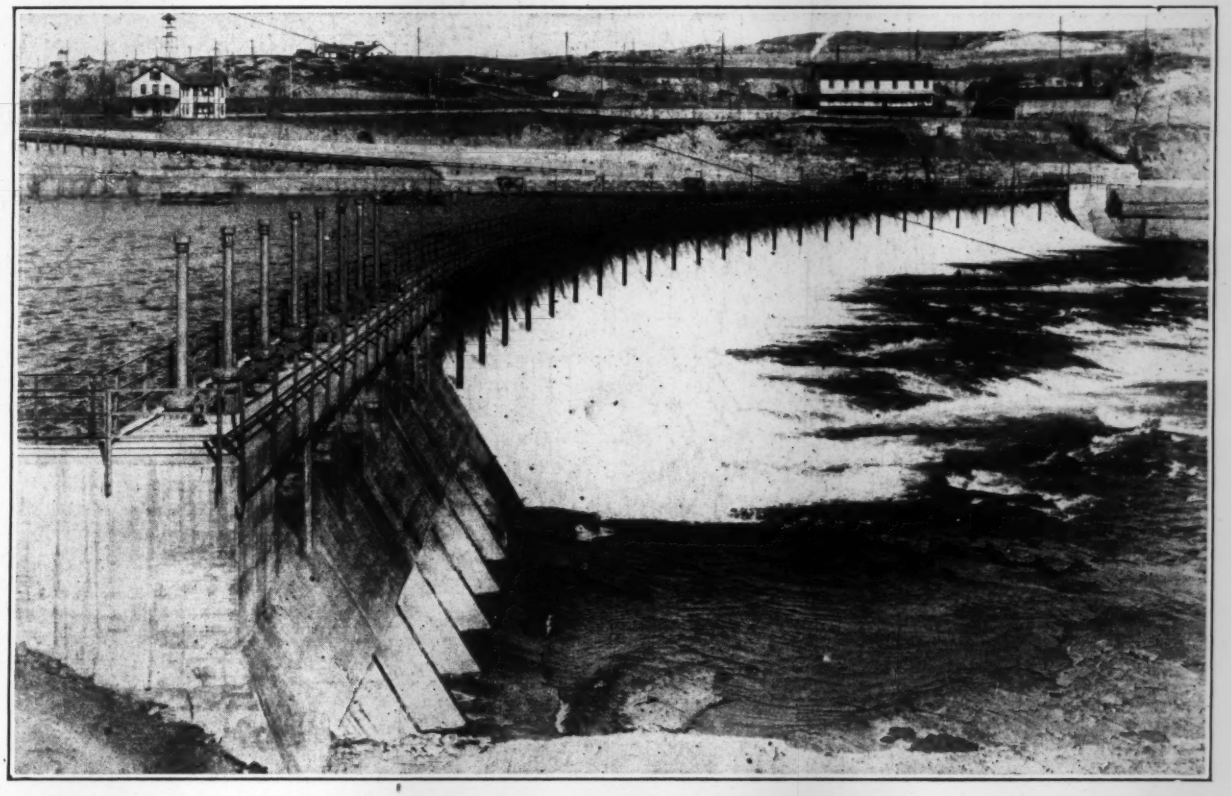


FIG. 3—SPILLWAY DAM AT BLACK EAGLE FALLS, MONT.
Waste gates at left. Headrace beyond farther end of dam.

In June, 1908, a flood of 120,000 sec.-ft. destroyed the north wall of the headrace, and the entire headrace was rebuilt with concrete walls and enlarged to include the two waste gates. A second set of headgates was

installed, about 60 ft. below the old canal gates, these being considered unsafe. There were seven new gates, each 7x10 ft. The power houses were of masonry. The tailrace on the north side is about 1,500 ft. long and 175 ft. wide, with a river protection wall extending its entire length.

Plans for Redevelopment—In planning the redevelopment at this site the engineers considered the various factors entering into the economic utilization of the power possibilities. The headwater elevation was determined by a survey of the property damage involved and particularly by the limit set for safe operation of the sewers of Great Falls. The tailwater elevation was fixed by economic calculations, balancing its cost against the value of the gain in power. The power plant capacity was fixed by the minimum average river flow and the load factor of the Montana Power Company's system.

With these facts determined, it was evident that the installed capacity of 18,000 kw. under 50-ft. net head would be practically a continuous output so far as river flow and load were concerned. After careful comparisons of the relative costs and outputs of Francis and propeller type units, the latter were selected and the estimated saving in first cost and installation were more than realized.

Of the old north plant, only the headrace and tailrace could be utilized. The crib dam showed considerable wear on the deck, due to the action of sand and ice, while under full head there was excessive leakage both under the dam and through the deck. With a new headwater level 11 ft. above the old crest, this leakage would have been prohibitive and the cost of repairs compared unfavorably with that of a new structure.

Dam and Gates—The new dam, 50 ft. downstream from the old one, is about 830 ft. long and raises the water 25 ft. above the streambed, diverting the flow into the headrace canal, which is approximately 420 ft. long, 80 ft. wide and 25 ft. deep, terminating at the power house. The tailrace is 1,500 ft. long, discharging into the river.

This dam, shown in Figs. 3 and 4, is of ogee gravity section, founded on sandstone bedrock, with a cutoff toe 5 ft. wide and 2½ ft. deep doweled to the rock with 1¼-in. square bars 5 ft. c. to c. Seams under the foundation are pressure grouted and a drain of porous tile runs the entire length of the dam, with bleeder drains every 25 ft. leading to the downstream toe. The old intakes on the south side were closed by the new abutment, adjacent to which is the waste gate section, having eight undersluices 9x9 ft. with motor-operated timber gates.

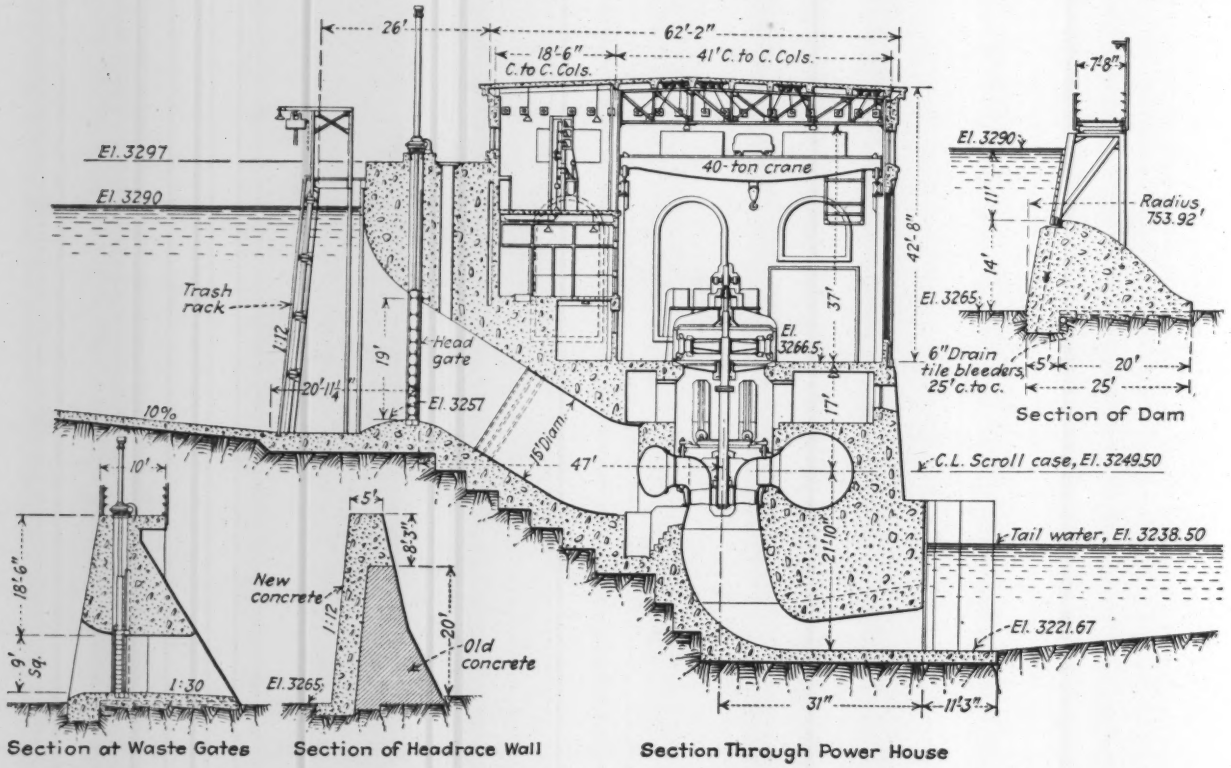


FIG. 4—POWER HOUSE AND DAM AT BLACK EAGLE FALLS

The spillway portion of the dam, 13 ft. high and 25 ft. wide, is built on a curve of 753.92 ft. radius. A steel flashboard structure divides the 627-ft. spillway into 25 bays of 25 ft. each. About 11 ft. of flashing is carried normally and provision is made for tripping the intermediate flashboard beams in case of emergency. A working deck extends the entire length of the dam and has a 36-in. track for moving a hand-operated crane to handle the flashboards and flashboard beams. A 6-in. city water main is carried through the dam for the service of the power house and the Anaconda reduction works. A short north abutment connecting the dam and the headrace furnishes anchorage for a 400-ft. trussed timber boom extending from the abutment to the north shore to protect the headrace from heavy trash and ice.

Headrace and Intake—The headrace is formed by two concrete gravity-section walls, founded on rock and doweled to it at 5-ft. intervals, as shown in Figs. 2 and

4. They were constructed by adding new concrete on the top and inside faces of the existing walls. At the entrance is a bridge, giving four 20-ft. clear openings between 4-ft. piers, with stop-log grooves and a steel and timber working deck and walkway. The headrace tapers in width from 96 ft. at the bridge to 60 ft. at about 75 ft. from the racks and then widens again to 96½ ft. at the racks, located at a distance of about 420 ft. below the bridge.

A mass concrete structure built integral with the power house foundation forms the intake with three bell-mouth openings leading to the headgates (see Fig. 4). Racks covering the entire face of the intake are built of 4x⅜-in. bars, spaced 4⅜ in. c. to c., in removable sections, giving a net effective area of 2,885 sq.ft. Stop-log grooves are provided in front of the headgates and a 3,000-lb. overhead-motor-driven trolley hoist with rake serves the entire rack area. Compressed air is piped to the foot of the screens for cleaning. Three structural steel headgates 15x19 ft. close the openings to the penstocks. They seal bronze to bronze, with one sealing strip of bronze on the gate and one on the guide. The motor-driven hoists are of the double-stem screw type having phosphor-bronze nuts and worm wheels and hardened steel worms, completely housed and running in oil. They are provided with limit switches, friction couplings and positive stops against accidental overtravel.

Power House—The power house and intake are practically one structure, having a common foundation and being separated only by an 8-in. gap which serves to collect the water leakage through the intake and convey it to drains leading into the tailrace. The building, Figs. 1 and 4, has a structural steel frame with concrete walls, partitions, floors and roof, and steel sash and doors. It is 62x138 ft. and 37 ft. high from generator floor to roof truss, divided lengthwise into six 21-ft. bays and crosswise into a 40-ft. generator bay and 18-ft. electrical bay. This building houses all of the hydraulic and electrical equipment and is provided with locker and toilet rooms, oil storage, shop and general storage space. The switchboard room is inclosed in a double glazed steel partition with floor ventilators and sidewall ventilating ducts leading to the roof.

Electrical Features—The adjacent plant of the Anaconda Copper Mining Company furnishes an outlet for the output of generator voltage. The station is also connected to that company's substation, which connects to the Montana Power Company's 100,000-volt transmission system. This allows the Black Eagle station to deliver its output locally with practically no transmission losses and no expense for transformers, and at the same time to float connected to the 100,000-volt system as an outlet for power not required at generator voltage. Three 7,000-kva., 6,600-volt, three-phase vertical generators are each directly coupled to a 9,300-hp., four-blade propeller-type hydraulic turbine with runner 127 in. in diameter.

Construction Work—The Black Eagle redevelopment, as planned by Charles T. Main, Inc., was built on force account by the Montana Power Company, under the supervision of Frank Scotten, general manager of the Great Falls district. The work of dismantling the old plant began in April, 1926; the first concrete for the new work was poured in September, 1926; the first unit was placed in operation in August, 1927, and the completed station was placed in regular operation in September, 1927.

Changes in Tidal Datum Planes

Changes in Tide Range Often Result From River and Harbor Work—Variation in Mean Low Water Follows

By H. A. Marmer

Assistant Chief, Division of Tides and Currents, U. S. Coast and Geodetic Survey

TIDAL datum planes have a number of advantages as planes of reference for elevations in engineering work. Simplicity of definition, freedom from arbitrariness, accuracy of determination and certainty of recovery, even though all bench mark connection be lost—these advantages are sufficient to account for the adoption of tidal datum planes by the engineering services of the government and by the engineering profession generally.

Although the basic or primary tidal datum plane is that of mean sea level, certain kinds of engineering work require low-water or high-water datums, which are readily determined from a record of the rise and fall of the tide.

From the tide observations at any point the various datum planes are determined as corresponding to certain heights on the fixed tide staff used in making the tide observations at that point. As soon as the tide staff is connected by leveling with one or more bench marks it serves as a medium through which the engineer relates his elevations to the various tidal datum planes.

Constancy in Tidal Datums—In the use of tidal datums as planes of reference for elevations, there is an implication that such datums at any given place remain constant over relatively long periods of time. Underlying this implied constancy are the tacit assumptions of coastal stability and constancy of hydrographic features. With regard to periods of time measured in thousands of years, local changes in relative elevation of land to sea of considerable magnitude have been fully demonstrated. Some geologists maintain that such changes at the rate of about a foot a century are taking place now. But for the lesser periods of time involved in everyday affairs experience has shown that such changes, as a general rule, are so minute that for the practical purposes of datum planes they may be disregarded and coastal stability taken for granted.

The changes in hydrographic features that bring in their train changes in datum planes are those that affect the local tidal régime. With regard to such changes in hydrographic features, it is necessary to distinguish between the open coast and inland bodies of tidal water. While the open coast is at all times under attack by wave and current and thus subject to change, such changes are relatively slight and only rarely bring about changes in the rise and fall of the tide, even over a period of a number of years. Hence along the open coast it may be taken for granted that tidal datum planes remain constant for periods covering many years. But in inland bodies of tidal water, changes in hydrographic features are as a rule followed by changes in the tidal régime, which are reflected by changes in the tidal datum planes. The changes that may be expected under different conditions will be discussed here briefly. It will be of advantage, however, to consider also in this connection the changes in tidal datums that result from changes in relative elevation of land to sea.

Changes Due to Subsidence—If a coast is undergoing

a slow, gradual subsidence, the first effect would be an apparent elevation of all the tidal datum planes with respect to local bench marks by the same amount, this being the amount of subsidence. Thus, suppose that after a number of years the subsidence of the coast in question amounted to one-tenth of a foot. Obviously, mean sea level and also the low-water and the high-water planes would, with respect to the local bench marks, stand one-tenth of a foot higher than at the beginning of the period.

But if the subsidence continues so that it becomes of sufficient magnitude to alter materially the hydrographic features of the coast, changes would ensue in the tidal régime along the coast. As a consequence the different datums would change differently, as the following considerations will make clear.

It is evident that, whatever the changes in the rise and fall of the tide along an open ocean coast due to gradual subsidence, mean sea level fixed with respect to local bench marks will show an apparent change of the same magnitude as the subsidence, but in the opposite direction. That is, if S is the subsidence in feet, from the beginning of the period, the mean sea level would appear to have risen S feet. But, if because of the alteration of the hydrographic features consequent on this subsidence, the range of the tide is increased by A feet, mean high water will appear to have risen $S + \frac{1}{2} A$ feet, while for mean low water the apparent rise will be $S - \frac{1}{2} A$ feet, since high water and low water, respectively, lie above and below sea level a distance equal one-half the range of the tide. Thus, the datums of mean high water, mean sea level and mean low water, with respect to local bench marks, will be changed by different amounts.

On a rising coast the changes that would take place in the tidal datums are similar but in the opposite direction to those just discussed.

Alteration of Hydrographic Features—It is in inland tidal waters that changes in the datum planes due to alteration of hydrographic features become important. On the open coast it is evident that only profound changes in the hydrographic features can bring about changes in the range of the tide. But in inland tidal waters, because of the relatively limited areas and depths involved, changes in the features of considerably lesser magnitude are sufficient to change the range of the tide and thus bring about changes in datums. While the quantitative relations subsisting between changes in the body of water and changes in datums are difficult to establish from general considerations, qualitatively we may determine the changes in the datums that will follow proposed changes in the hydrographic features.

Tidal rivers furnish good examples of such inland bodies of water. These rivers serve as highways to the sea for numerous ports, some of which are situated many miles from the coast. With the increased draft and size of modern vessels, changes in depth or other alterations are frequently found necessary; and such engineering operations, if of considerable magnitude, result in changes in the local tidal datum planes.

The tides in rivers are due to the tides sweeping into them from the seas into which they open. Normally, the tide travels upstream until stopped by falls or rapids. If the mouth of the river is widened or deepened, this makes for a freer entry of the tide from the open sea and thus for a greater rise and fall of the tide. As a first effect, therefore, of widening or deepening a tidal river at its mouth we may expect a rise in the high-water datums and a fall in the low-water datums. This effect, it is reasonable to expect, will generally be greater near the mouth of the river, becoming gradually less going upstream.

Tidal rivers serve, however, not only as highways for the tide but also as channels for carrying to the sea the drainage waters from large territories. Normally the cross-sectional area of a river increases seaward due to the seaward slope of the river bed and the increasing width between banks. As a consequence the mean river level in a tidal river becomes higher in going upstream. Thus precise leveling by the Coast and Geodetic Survey shows that at Philadelphia, about 100 miles up the Delaware, the mean sea level (or mean river level) is about three-quarters of a foot higher than mean sea level on the coast, notwithstanding the fact that the range of the tide at Philadelphia is somewhat greater than at the mouth of the river. Widening the mouth of a tidal river increases the cross-sectional area of the channel through which the drainage waters flow into the sea. As a consequence of the enlarged channel, the drainage waters have freer outlet, which results in a lowering of the mean sea level some distance upstream. Deepening the mouth has a like effect; in addition, by reducing the friction per unit volume of water, it brings about a further lowering of the mean level of the water.

If, as a result of widening and deepening the mouth of a tidal stream, the mean sea level at a given point of the river is lowered D feet and the range increased A feet, the changes in the different datums would be: mean sea level, lowered D feet; mean high water, lowered $D - \frac{1}{2} A$ ft.; mean low water, lowered $D + \frac{1}{2} A$ ft. The slope of mean sea level up a tidal stream is relatively slight, but the increase in range of tide consequent upon improvement is relatively large. For example, at Glasgow, on the Clyde, the range was increased 8 ft. by river improvements. It follows, therefore, that as a rule in the formulas given D is less than $\frac{1}{2} A$. This means that $D - \frac{1}{2} A$ is negative and that high water, instead of being lowered, is raised somewhat. Low water, however, is lowered by the full amount of the increase in the half range plus the depression of mean sea level.

These considerations become of special importance in connection with the improvement of tidal rivers, since the depths in these are almost without exception referred to some low-water plane. When improvements are contemplated, the wording is generally to the effect that a certain depth at mean low water (or mean lower low water) is to be attained. At first thought it would appear that, if the desired depth below mean low water is a and the present depth is b, the channel depth to be dredged is $a - b$. But, as the considerations outlined above show, this is not the case, for the datum plane of mean low water is different in the two cases, and the depth to be dredged will be $a - b$ plus the lowering of river level plus half the increase in resulting range of tide.

Highway Work in Ontario

With the letting recently of contracts totaling more than $1,000,000, the Ontario Department of Public Works and Highways has awarded, since the present season opened, contracts involving an outlay of approximately $7,250,000. This latter figure represents the construction of 123 miles of concrete pavement, 67 miles of black base and 139 miles of grading. At the close of the 1927 season 1,500 miles of the 2,400 miles of provincial highways were hard surfaced. This season's work will substantially increase the mileage of hard-surfaced road.

Sewage-Works Construction at Cleveland, Ohio

Well-Point Drainage Highly Successful—An Effective Form for Tank Bottoms—Belt Conveyors Place Filter Stone—Surface Protection of Concrete Elaborate

By A. A. Burger

Associate, George B. Gascoigne, Cleveland, Ohio

Close Liaison of design and construction thinking in building the new southerly sewage-works at Cleveland, Ohio, developed plant co-ordination and an orderly construction procedure, which carried the work through astonishingly free from difficulties. The site was not ideal; it was long and narrow, requiring extended distribution of operations longitudinally and limiting the plant operating room transversely. It presented a complex problem in handling water: it acted as a sump for surface drainage, it was soaked with groundwater, and finally it offered the hazard of backwater overflow from a flooded river. Because the engineer in his planning had design and construction jointly in mind, with keen knowledge and judgment of construction methods and available equipment, none of these difficulties was permitted to be an obstacle to progress. They were all scheduled in the construction plan and approached with foreknowledge. —Editor.

THE Cleveland southerly sewage-works are located on 260 acres of low, swampy ground 6½ miles south of the city and on the Cuyahoga River and the Ohio Canal, as shown by Fig. 1. Calculated from city datum, normal water level in the river is +3. The canal level is maintained at +17. The general ground level is +20, but in 1914 the areas occupied by the humus tanks and the trickling filters had been excavated to +8½. On all sides except that fronting on the river are ridges rising sharply to +125. With the road embankment at +30, the site was a natural sump for surface runoff. This and a high groundwater level made drainage a controlling operation.

Sewage-Works Structures — The southerly sewage-works are the last of three constructed by the city. They will handle the sewage of a population of 400,000 as of 1940, and are designed to be extended as need arises. The structures comprise an overflow chamber, screen building, four grit chambers with mechanical grit-removal equipment, a Venturi vault and building, a battery of 24 Imhoff tanks with two control houses, pumping station, garage, three twin dosing tanks and six acres of trickling filters, three humus tanks with continuous sludge-removal equipment, an office and laboratory building, miscellaneous conduits and pipe lines, dikes, roadway and parking, as well as 3,600 lin.-ft. of 8½-ft. monolithic concrete outfall sewer. Present plans provide for the construction of 94,000 sq.ft. of glass-covered sludge-drying beds, which will eventually be a part of the complete works. The beds have not yet been contracted for.

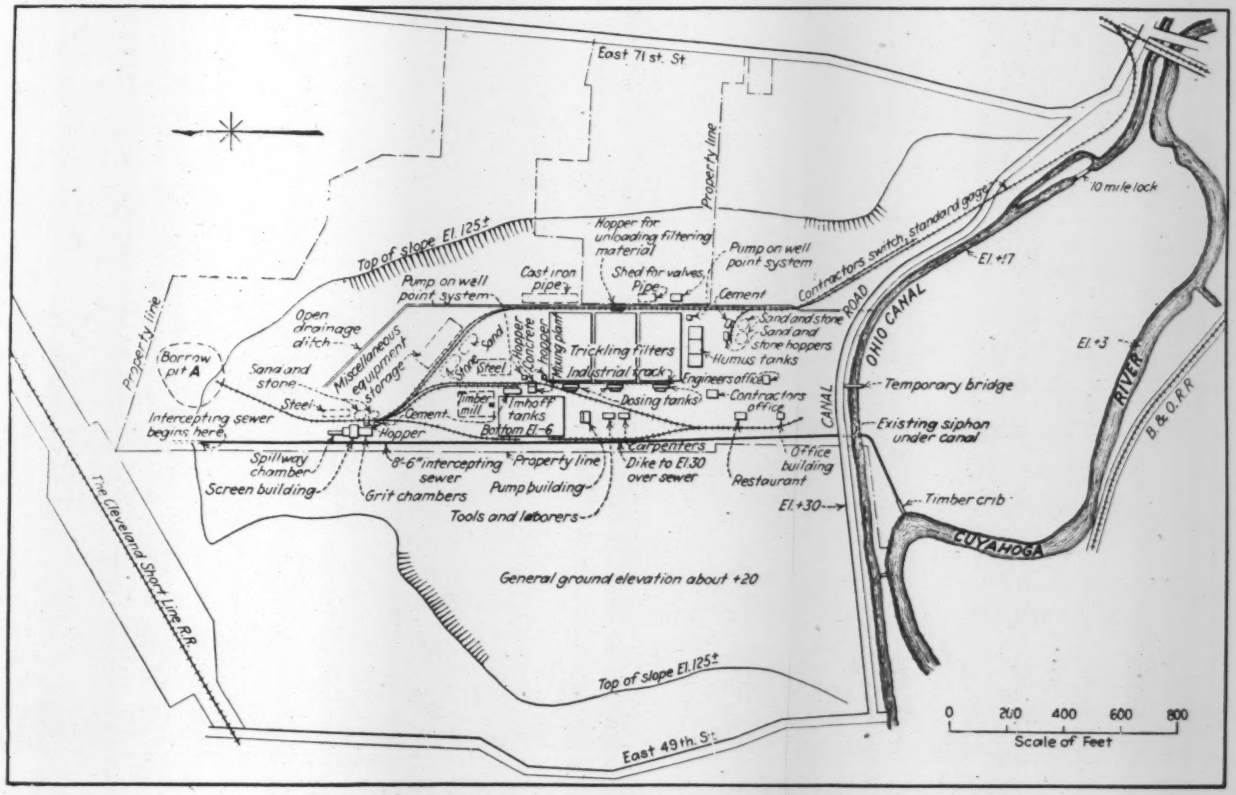


FIG. 1—LAYOUT OF CLEVELAND SEWAGE-WORKS, SHOWING CONTRACTOR'S PLANT

The work included approximately 200,000 cu.yd. of earth excavation, 42,000 cu.yd. of concrete, 2,000 tons of cast-iron pipe, 97,000 cu.yd. of stone for trickling filters, 300,000 cu.ft. of buildings and 3,600 lin.ft. of 8½-ft. intercepting sewer. The general contract included all the various special trades such as heating, plumbing, electrical wiring, pumping equipment installation, and buildings. This procedure permitted the best progress to be made and eliminated the possibility of delays which sometimes occur when work of this nature is divided into several contracts. Also, responsibility for the successful operation of the various portions of the work was thus centered.

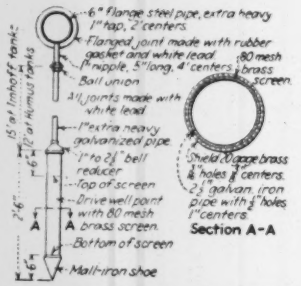

6" flange steel pipe, extra heavy
1" tap, 2' centers
Flanged joint made with rubber gasket and white lead
80 mesh brass screen
1" nipple, 5" long, 4' centers
Ball union
All joints made with white lead
1" extra heavy galvanized pipe
1" to 2½" bell reducer
Top of screen
Drive well point with 80 mesh
A brass screen
Bottom of screen
Malt-iron shoe
15'-0" at Imhoff tanks
12'-6" at humus tanks
2'-6"
1'-6"
Shield 2 gage brass holes ¼" centers
2½" galvan. iron pipe with ¼" holes 1" centers
Section A-A

FIG. 2—DETAILS OF WELL POINTS USED IN DRAINAGE SYSTEM

General Plant Plan—The construction site was about 800x3,000 ft. The work being spread over a considerable distance longitudinally, it was thought that all requirements would be best served by establishing three major operation centers as follows: (1) humus tanks; (2) Imhoff tanks and trickling filters; (3) grit chambers. These centers were at the south, central and north ends of the works, respectively. Other, or intervening, structures were handled from the point most convenient. The general layout of the contractor's plant is shown by Fig. 1. At each of the construction centers excavating and concreting equipment was installed complete in all details. The capacity, type and permanency of the equipment varied with the requirements of the work at each center.

Excavating Plant and Methods—The notable feature of the excavation was that practically all the excavated material was placed directly where required in the permanent grading or backfill. There were four divisions of earth-moving operations: (1) humus tank excavation; (2) Imhoff tank and trickling filter excavation; (3) grit chamber excavation, and (4) dike construction. At the humus tank the pit was 12 ft. deep for a structure 75x225 ft. A dragline took out the entire 9,200 cu.yd. and placed it in permanent fill adjacent to the tank. Similarly the 6,000 cu.yd. from the grit chamber pits was taken out by a small steam shovel and cast into banks for adjacent grading fill.

The main excavation was for the Imhoff tanks, about 90,000 cu.yd. in an area 300x400 ft. The maximum depth of foundation was 27 ft. The pit was taken out in two lifts by power shovel and dragline excavator, and the spoil was used in raising the +8½ elevation of the filter area to +12½, which was the level of the filter footings. This fill was placed in layers and allowed to settle all winter before being built upon. With both shovel and dragline an output of about 1,200 cu.yd. in ten hours was obtained.

Dike construction was a backwater flood protection measure. The embankment was for the most part directly over the sewer and followed sewer construction. It was built from borrowpit, from which, as shown by Fig. 1, a standard-gage track ran parallel to the dike and about 40 ft. away. Between track and dike a shallow wide trench was cut into which the trains of five to seven 12-yd. cars of borrow dumped. From the dump the material was retrieved by a skid-mounted dragline with a 2-yd. bucket on a 75-ft. boom, which delivered onto the dike. A settlement period, through the winter, of approximately six months was allowed before constructing the roadway which occupies the top of the dike.

FIG. 3—PILES WITH ANCHOR BRACKETS AND METAL FORMS
The well-point system and pump house are shown in background.

Surface and Groundwater Drainage—The controlling task of excavation was drainage. The area to be occupied by the filters and humus tanks, approximately ten acres, was covered with about 2 ft. of water at the start of construction. During low flow in the Cuyahoga River it was possible to let portions of this water out by gravity through an existing 24-in. drain and siphon (Fig. 1) beneath the canal. The remainder of the water was pumped into an existing surface drainage ditch immediately adjacent to and along the east side of the site. This ditch discharged into the canal.

Subsurface drainage was by well points, in two units, one for the Imhoff tanks and the other for the humus tanks. At the Imhoff tanks, the material in the top 10 ft., or between El. 21 and 11, was mostly clay with pockets of fine blue sand. This sand when wet was unsafe for a power shovel even when supported on timber mats. The material below El. 11 was fine sand and gravel. An

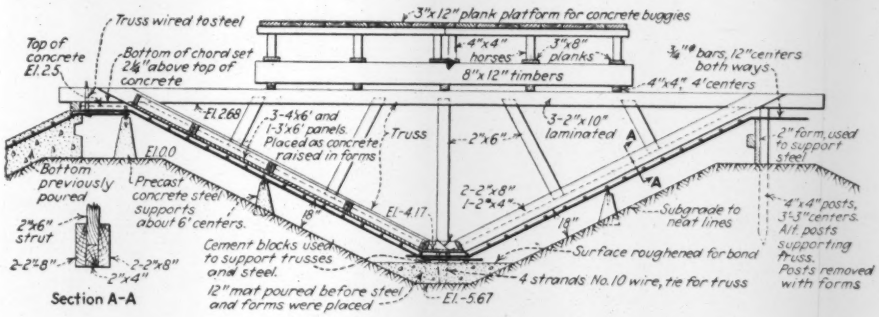


FIG. 4—FORMS FOR IMHOFF TANK BOTTOMS

attempt to make the first cut with a shovel emphasized the necessity of removing the subsurface water. A trench was excavated to El. 9, completely surrounding the area. The header pipe for the point system was then placed in the trench at about El. 9.5, allowing sufficient clearance between it and the tank structures. The header pipe formed a closed circuit and was fitted with gate valves at intervals of approximately 150 ft. Also, a check valve was installed in the suction line to each pump about 20 ft. from the pump connection. In this manner a steady vacuum was maintained on the header system at all times. Any section could be cut out of service without interfering with the operation of the remainder of the system.

The header pipe (Fig. 2) consisted of 6-in. extra heavy steel pipe tapped 2 ft. on centers on the under side for 1-in. pipe. Nipples of 1-in. extra heavy pipe 5 in. long were fitted into alternate taps; other taps were plugged. Below each nipple a well point, with a length of 1-in. extra heavy galvanized pipe attached, was jetted into place and connected to the nipple by means of a ball union. All joints were generously coated with white lead in oil to insure absolute airtightness.

City water pressure at 100 lb. was used to get the pipes into the ground. An A-frame with pulleys and lifting ropes, and a 20-ft. piece of 2-in. pipe, with a 1-in. nozzle, formed the jetting apparatus. Water was led to the jet pipe by a 2-in. hose from the city main.

Connected to the header were two horizontal plunger pumps each direct connected to a 25-hp. Diesel engine. Each pump had a rated capacity of 1,200 g.p.m. against a head of 15 ft. It is estimated that the average delivery of each pump was 600 g.p.m. The pump house was located just east of the Imhoff tanks and was set at El. 12. The pumps discharged into the open drainage ditch at El. 20.

The procedure at the humus tanks, which occupy an area of about 100x250 ft., was similar to that at the Imhoff tanks. The original ground surface was at about El. 9 and the deepest excavation was at El. 0. The material excavated was coarse sand overlaid with about 2 ft. of clay. A 6-in. header was installed at El. 11 along the north and east sides of the structure. This is shown by Fig. 3. One pump and drive of the same size and type used at the Imhoff tanks removed the water and discharged into the drainage ditch.

A decided advantage in the use of well-point systems as disclosed in this operation is that the side slopes will stand quite steep and that the immediate area is always dry except for a short period after a rain. These conditions are seldom, if ever, secured when sump pumping or other methods of groundwater removal are employed. With the foundations presenting a uniform dryness at all times, it was easier to obtain good workmanship, and the placing of reinforcing steel, forms and concrete was greatly facilitated. Rains did not affect the working conditions except for the relatively small amount of water which fell immediately within the excavated areas, and this disappeared quite rapidly.

At the Imhoff tanks it was observed that the groundwater assumed a slope of about 1 to 10 from the points where they were in operation. The steepness of this slope would undoubtedly vary with the kind and fineness of the soil and length of time the points were in operation. Likewise, it would be increased by rains. Pumpage from the point system usually increased slightly for about twelve hours after a rain, when it would gradually drop back to normal again.

A few of the fundamental points to be considered in the use of a well-point system are as follows:

1. The effective elevation to which the system will function will depend upon the maximum suction lift of the pump used. Generally this is not more than 20 ft. and preferably it should be kept below this figure.

2. All points should be placed at or below the elevation to which it is desired to have the system effective. In other words, water will not be removed below the highest point in the system.

3. All joints in the suction lines, header system and points must be made airtight.

4. In long runs it is desirable for the purpose of detecting leaks and for maintaining the system in operation to install cutoff valves at intervals in order that the location of leaks may be easily detected.

Concreting Procedure—Separate mixing plants were set up at (1) the humus tanks, (2) the Imhoff tanks and filters and (3) the grit chambers. At the humus tanks, 2,500-cu.yd., and at the grit chambers 2,000-cu.yd. were placed. Paving mixers were charged by batch-box trains on industrial railways from proportioning plants. The mixers were ¾-yd., the track 24-in. gage, the cars six or eight to a train and the batch boxes two to a car. The mixers discharged into buggies and were shifted as seemed desirable to keep down the buggy haul.

For the Imhoff tanks and the filters, which required 35,000 cu.yd., distributed about half and half, a stationary mixing plant was built. This was of the three-story type—mixers, batchers and bins—and discharged to a 165-ft. tower hoist, from which concrete was delivered through chutes directly to the forms, or to a secondary hopper located at the Imhoff tanks, or to a secondary hopper for the trickling filters. From the secondary hopper at the Imhoff tanks the mixed concrete was buggied to the forms.

For delivery to the filters from the secondary hopper a narrow-gage track and 1-yd. hopper-bottomed cars were used. These cars had side discharge and were shifted by gasoline locomotives. Generally two cars were operated as a train, and when the volume warranted, two or more trains were used. When floors or footings were being poured, the concrete was discharged from the cars directly into place or, when required, into buggies or wheelbarrows and delivered in this manner. When walls were being poured, the mixed concrete was discharged from the cars into the hopper of a portable belt conveyor 60 ft. long with a 24-in. belt and thus (Fig. 4) into the forms.

Successful handling and placing of concrete with the belt conveyor required that the consistency of the mixed concrete be kept quite uniform. Too much mixing water would cause a separation of the aggregates and mortar in transportation and difficulty at the belt conveyor. Likewise if too little water were used, the mixed concrete would not flow freely from the hoppers. The amount of mortar that was lost at the conveyor belt appeared to be so little that it could be reckoned as negligible.

A 1:5.7 concrete was used throughout. A practical application of the water-cement ratio was followed and in general not more than 7½ gal. per cubic foot of cement was used, including moisture in the aggregates. Modifications of this were adopted where thin walls were being poured and where heavy reinforcement was encountered. This procedure was necessary to avoid excessive honeycomb. Test cylinders were made for approximately each 500 cu.yd., and in this manner a definite check was had upon the results being obtained. Slump tests were made as a guide for field inspection.

The fine aggregate used was well-graded, washed bank sand having a fineness modulus of about 3. The coarse aggregate, which was crushed limestone with a uniform sizing ranging from ¼ to 1½ in., had a fineness modulus of about 7.8. Care was exercised in the storing and handling of aggregates to prevent the separation of sizes.

Special Form Construction—The bulk of the formwork was ordinary; the forms were made up at the mill (Fig. 1) in panels or units adapted for re-use. The noteworthy formwork was the bottom forms for the Imhoff tanks. Twelve trough bottoms, each about 105x30 ft. in plan and 7 ft. deep, arranged on either side of the central gallery, were required. The side slopes on these bottoms, which are about 1 on 2, were considered too steep for the direct placing of the concrete without the use of forms. After the trough subgrades were finish-graded to the required lines by the aid of an inverted truss templet, a 12-in. layer of concrete was poured in the bottom. Wires for anchoring the concrete form trusses were placed in this concrete. The upper surface was not finished, but was left rough, to afford bond with the concrete to be placed subsequently.

Reinforcing steel was supported on precast concrete blocks and piers set in the subgrade as shown by Fig. 5. After the reinforcing steel had been placed the erection of forms was begun. Timber trusses (Figs. 5 and 6) were placed to line and grade at intervals of 6½ ft. for the full length of the trough. Panel forms of the proper length were placed between the trusses as the concrete was poured. Runways were laid above and supported by the trusses. Buggies delivered the concrete, and it was directed into place by small portable chutes. In general, only one panel was placed at a time, the panel next higher on the slope being placed after the lower one was completely filled with concrete. This procedure, especially since the panels were only about 3½ ft. wide, permitted ready spading of the concrete. Concrete was poured along each side of the trough progressively and was kept at about the same elevation on both sides. Each trough required approximately 225 cu.yd. of concrete, and only one complete trough was poured each day. Obviously it is important when placing concrete in this manner that the truss forms should be well tied down and that the occurrence of an unbalanced load on the sides of the trusses be avoided. Fig. 6 shows the forms in place before pouring.

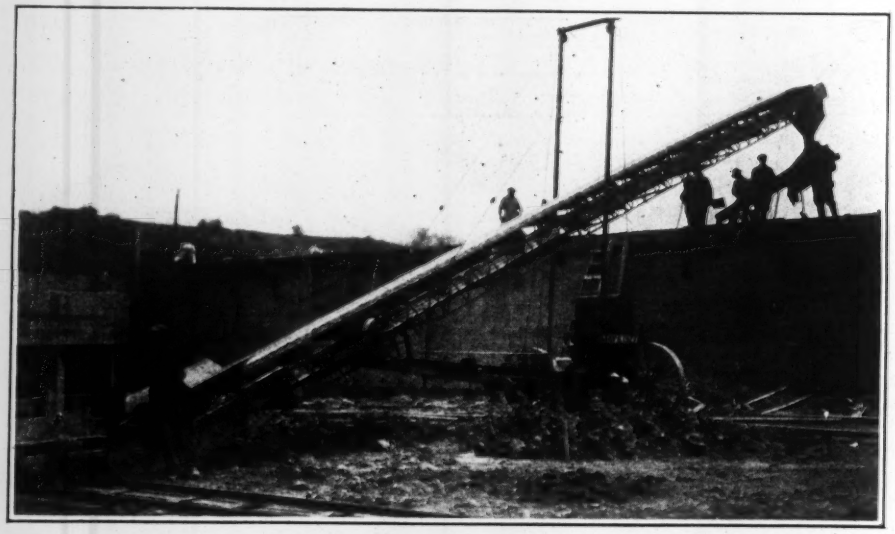


FIG. 5—PLACING CONCRETE WITH A BELT CONVEYOR

In the construction of the three humus tank bottoms, where approximately 500 wooden piles 25 to 30 ft. long were placed for the purpose of anchorage against floating, a unique method of forming was employed. The tops of all piles were fitted with structural steel brackets (Fig. 3) to insure positive anchorage of the piles to the concrete bottoms. Since a portion of the brackets and bolted connections extended beneath the plane of the bottoms of the tanks, provision was made in the plans to inclose each bracket with a concrete collar in the shape of a cylinder

approximately 2 ft. in diameter and 2 ft. long. Forms for these collars were made of 18-gage sheet metal with riveted splice joints. By using these metal forms, which were left in place, it was possible to complete the subgrading work before the pouring of the concrete collars was begun. This procedure expedited the placing of the concrete bottoms and permitted the collars to be cast monolithically with the bottom slab.

Placing Filter-Bed Stone—To meet time limits, to reduce costs and for convenience, it was desired to place all of the 97,000 cu.yd. of filtering material in the short period of three months.

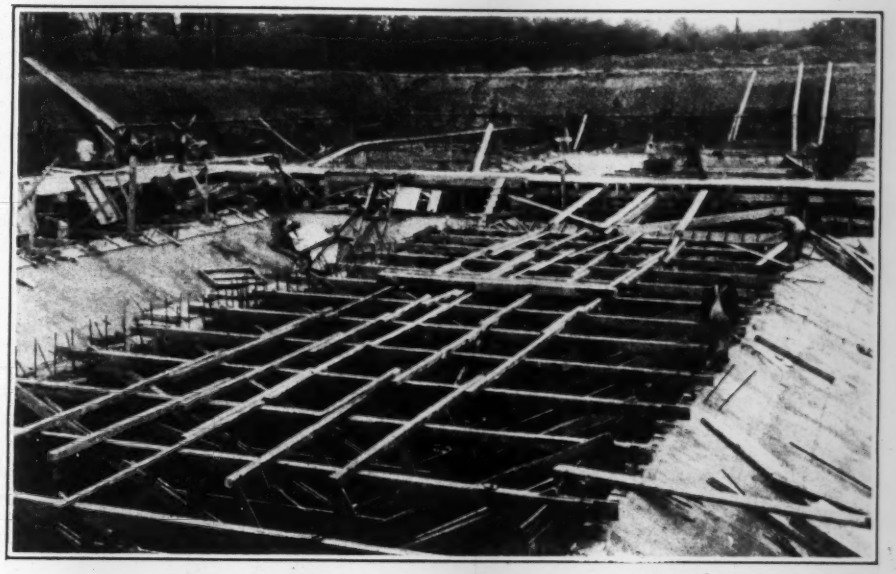


FIG. 6—PLACING FORMS FOR IMHOFF TANK BOTTOM

After a thorough canvass of standard contractors' equipment such as locomotives, tractors, cranes, industrial cars, portable conveyors, trucks and teams, it was decided that only two devices could be used to advantage, an overhead cableway or belt conveyors. The cableway was eliminated owing to lack of space and to the uncertainty of being able to place the material in a satisfactory manner.

In the selection of the belt conveyor it was appreciated that the special equipment required would in all probability not be readily adaptable for further use; also, while the first cost of this equipment had to be such as to permit its being written off on the job, its construction had to be rugged and dependable in operation so that it would operate continuously during the placing of all of the material without danger of breakdown.

The limestone was shipped from quarries about 80 miles distant, making it necessary to schedule shipments in advance. Any breakdown or delay in the loading operation would mean an accumulation of cars, and the demurrage and lost time would soon absorb the money saved by using special equipment. It was essential, too, that the stone be placed, not dropped, on the clay floor system, to prevent breakage of the grids. It was further required that the larger-sized stone be placed directly upon the grids in order to prevent the sifting through of chips and the filling of the underdrains.

A general view of the filter beds and unloading equipment is shown by Fig. 7. The railroad siding was already installed parallel with the long side of the beds, the rails being at approximately the same elevation as the top of the wall. A track hopper about 14 ft. square and 10 ft. deep was installed under this track midway of the filter beds. The stone was received in hopper-bottom cars and discharged into this receiving hopper. Beneath this hopper a steel apron feeder was installed, which fed the stone at a uniform rate to an inclined belt conveyor. This conveyor was about 60 ft. long and elevated the material and discharged to a shuttle belt conveyor 325 ft. long. This conveyor in turn discharged to the distributing belt conveyor 387 ft. long, which was equipped with a self-propelled tripper. This distributing conveyor was mounted on tracks and at the start was located on the south end wall of the filter bed. The tripper chute was hinged and arranged so that it would distribute the material over an area 7 ft. wide and the full length of the bed. When this area was filled, narrow-gage tracks were laid on the stone, the distributing conveyor was moved out to the edge of the stone and the operation was repeated until one-half of the beds was filled, when the direction of travel of the shuttle belt was reversed, which allowed it to serve the distributing belt for the other half of the beds.

By giving the operation of the tripper careful attention it was possible to minimize the tendency for a separation

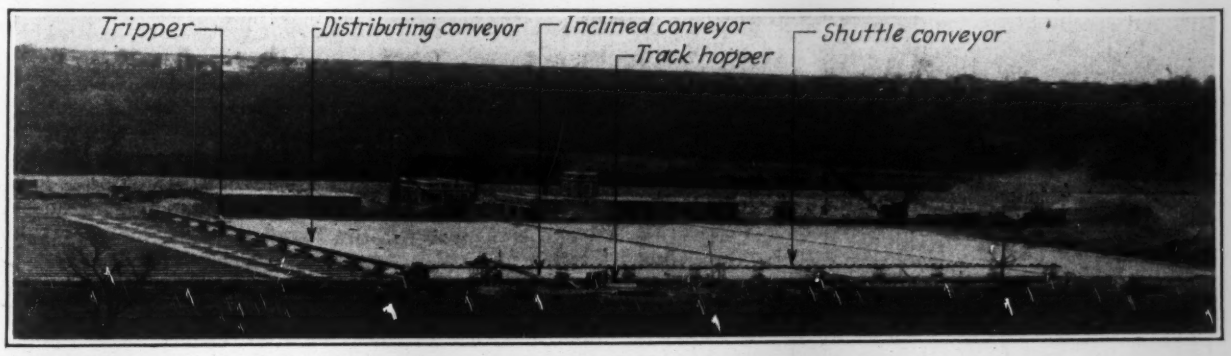


FIG. 7—BELT CONVEYOR PLACING FILTERING MATERIAL

of sizes. Also, it was found that during very dry weather the tendency for dusting and pocketing of fines made during handling was effectively lessened by the application of a spray of water on the stone as it was elevated from the track hopper. Too much water caused these fines to adhere to the belt, a condition which had to be guarded against on account of excessive wear on the belt. In general the larger pieces of stone tended to roll to the bottom and prevent the finer stone from sifting through the grids. To catch the passing fines, long strips of paper were placed under the grids and pulled out after the grids were covered. All belts were 24 in. wide, and at times they carried 2,000 tons in an eight-hour day.

Finishing Exposed Surfaces—A special finish and protective treatment was given to minimize the absorption of moisture by the concrete and thus reduce its probable disintegration by expansion and contraction or by freezing and thawing. Provision was made for restoring the treated surfaces to natural concrete texture and color by the application of a thin coat of cement and sand grout. This surface coat was then densified by the application of a fluosilicate hardener.

In general, the removal of form marks and heavy projections was accomplished by air-driven concrete finishers and chisels. The surface was then washed with clear water and the first application of iron was placed by means of an air spray. After the first coat had become oxidized a second coat of iron was applied in the same manner. After placing the second coat the surface was permitted to stand for about two days. The surface was then washed free of excess iron and a thin coat of cement mortar applied. The mortar coat was kept moist until thoroughly set. The cured mortar surface was then given two spray coats of hardener.

Approximately 40,000 sq.yd. of surface was treated in this manner. Some points to be observed in connection with the successful application of this treatment are as follows:

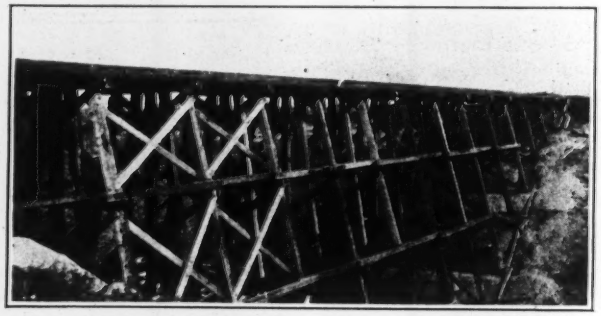
1. All excess iron must be removed prior to applying the cement mortar coat.
2. Form marks, indentations and projections cannot be completely obliterated by the mortar coat.
3. A coarse sand in the mortar will not give a very satisfactory finish.
4. The mortar coat must be applied very thinly—not over $\frac{1}{16}$ in. thick.
5. The mortar coat must be kept moist by spraying with water until set.

Direction—The southerly sewage-works is being constructed by contract for the city of Cleveland, of which W. S. Ferguson is the director of public service and Robert M. Hoffman is commissioner and chief engineer. Plans and specifications for the work were prepared by George B. Gascoigne, consulting sanitary engineer, who is also supervising the construction. The writer, who is associated with Mr. Gascoigne, had immediate charge of the design and construction of the work. The Mellon-Stuart Company, Pittsburgh, Pa., was the general contractor for $2,659,211. The outfall section of the intercepting sewer was built by the Graham Henderson Company, Cleveland, at a cost of $220,695. The contract was awarded on Dec. 23, 1925, but actual construction work was not begun until June, 1926. The work was done under the immediate supervision of J. P. Krager, vice-president, and was directed by James M. Markey, superintendent, and J. W. Holman, chief engineer, for the contractors.

Work on Hudson Bay Railroad Progressing Rapidly

End of the 1928 Season Will Find All But 54 Miles Completed — Conditions Favorable for Construction and Operation

THE Hudson Bay Railway, which will provide the grain regions of western Canada with an outlet to the sea at a new port 300 miles farther west than Chicago, is being rapidly pushed to completion. The contractors intend to build 100 miles this year, leaving only 54 miles still to be constructed. The full length of the railway from The Pas, in Manitoba, to Fort Churchill, on Hudson Bay, is 510 miles. From The Pas it runs in a generally northeasterly direction to Mile 356, and then turns directly north to Churchill. Five main watersheds are crossed. The country is substantially flat,



TYPICAL TIMBER TRESTLE ON HUDSON BAY RAILWAY

with a series of lakes and rivers trending northeast. The greater portion is covered with a blanket of muskeg of varying depth, only a very small percentage of rock foundation or subsoil being exposed.

The original construction of the line, covering a period of six years, terminated with the railway built to Mile 332 by 1918. No further work was done until 1926, when the project was taken over by the Canadian National Railways. By this time a considerable amount of reconstruction was necessary. The original cross-ties, of native spruce, were worthless, and had to be replaced by more than 600,000 new ties. About 1,250,000 cu.yd. of material was used in raising and widening the embankments, about 165,000 cu.yd. of this being obtained from widening of the cuts. By the end of 1927 the work of rehabilitation had been practically completed.

In October, 1927, a contract was let to Stewart & Cameron, Ltd., of Winnipeg, for the grading and bridging of the extension to Fort Churchill. The track laying is to be done by Canadian National forces.

The original plans called for a terminal and transfer facilities at Fort Nelson, on Hudson Bay. Upon investigation by the Canadian Senate it was found that sufficient care had not been taken in making the selection and that a terminal at Fort Churchill, although it involved additional railway trackage of 87 miles, would effect a material saving in both time of completion and operating expense. After a thorough investigation of the situation by Frederick Palmer, of London, England, a report was made that the Fort Churchill port, including the extra railroad mileage, would cost only half as much as the Port Nelson project and that annual

HUDSON BAY RAILWAY AT BOWDEN, MAN.; TYPICAL OF THE COUNTRY THROUGH WHICH MUCH OF THE LINE RUNS

charges, including interest, operation and maintenance, would be $1,000,000 less. Surveys and borings proved that no unusual difficulties would be experienced in extending the line to Fort Churchill, consequently it has been designated as the terminal.

The character of the country has permitted the location to be in a generally direct route and with small percentage of curved track, there only being 12.6 per cent of the mileage which is not built on tangents. In many places there are stretches of straight track 10 to 15 miles long. Only a few curves are sharper than 3 deg. The gradients in both directions are very favorable. Northbound, the maximum is 0.4 per cent, compensated for curvature; southbound it is 0.6 per cent. In the grading of the roadbed, 90 per cent of the line is in embankment. Only 51 miles out of the 510 miles is in cut, of which 12 miles is in solid rock.

In the entire line there will be six steel bridges and 72 timber trestles, all designed to Canadian government "class heavy" specifications, equivalent to Coopers E-50 loading, and capable of carrying the heaviest locomotives of the Canadian National. The longest bridge crosses the Nelson River at Kettle Rapids, and consists of two 300-ft. spans and one 400-ft. span. All major bridge work has already been completed, the uncompleted structures at the northern end of the line being of minor character.

There will be four operating division terminals, including those at either end of the line. The terminal at The Pas consists of approximately 7½ miles of track, with storage capacity of approximately 200 cars. At Bowden, Man., there will be a terminal consisting of 3.64 miles of track and storage capacity for approximately 200 cars. At Mile 327 there will be a complete terminal layout consisting of 4.1 miles of track and storage capacity for 200 cars. The Churchill terminal has not yet been definitely planned.

Of the nineteen water stations planned, thirteen have been completed and are in use. Those at the engine terminals have a capacity of 60,000 gal.; the other line water tanks have 40,000 gal. capacity. They are all supplied from wells excavated either over springs or at the sides of rivers or lakes. Length of pipe lines from the wells to the tanks varies from 60 to 2,250 ft. and care had to be exercised to place the pipes deep enough so they would not freeze in winter.

Exclusive of engine terminals, there will be 61 passing sidings, having an aggregate length of 28.8 miles. The length of most of these is 2,300 ft., but they have been located and planned so that they can be extended, if required, to about 4,000 ft. In the division yards there is an additional trackage of 22.4 miles, thus making auxiliary trackage of 51.3 miles, or 10 per cent of the main line mileage.

Reporting on operating conditions, C. S. Gzowski, chief engineer of the construction department of the Canadian National Railways, said: "On account of the high character of the line in respect to gradients and alignment, and the further advantage of the direction of the predominating tonnage being largely down hill, during the period of mild weather this line can be operated economically. The lower temperatures of the winter season, materially affecting train loadings, will decrease tonnage very substantially for operating during that period. The snowfall, being moderate (as a rule not more than 18 in. or 2 ft. lying on the ground), will offer relatively small troubles from this cause. As the greater portion of the business will be to and from the port on Hudson Bay, which will be closed during the winter season, the main period of operation will be during the summer, when operating conditions will be most favorable."

To the end of the year 1927, in round figures $20,000,000 had been expended on the line. It is estimated that when the total expenditures on the extension to Churchill are completed, the full expenditure will be $28,500,000, but this last figure does not include the costs of the ocean terminal port.

A Century of Civil Engineering

Celebration of the Centenary of the Institution of Civil Engineers in London Brings to Mind the Great Advances Made by the Profession in the Hundred Years Since Its Founding

By Lucien A. Legros
Consulting Engineer, London, England

The Author of this paper is one of the most widely known consulting engineers in Great Britain. His membership in societies constitutes an imposing list and includes the Institution of Civil Engineers, Institution of Mechanical Engineers, Institution of Electrical Engineers, Institution of Automobile Engineers (past president) and Société des Ingénieurs Civils de France. He is an Officier de l'Instruction Publique (France), a Fellow of University College (London), a member of the Mechanical Warfare Board (Britain) and formerly a member of the Mechanical Transport Advisory Board and Technical Sub-committee. He has written extensively and is the author of papers in English on Typecasting and Composing Machinery, of papers in English and French on Chars d'Assaut et Matériel à Chenilles, Tanks and Chain-Track Artillery, Traction Across Country, La Production Industrielle et l'Habileté de l'Ouvrier, Skill in Its Relation to Production, and others. —Editor.

CELEBRATION of the centenary of the grant of a royal charter to the Institution of Civil Engineers of London serves as a vivid reminder of the vast strides that have been made by the profession in the last hundred years. In reality the Institution is 110 years old, the first meeting having been held in January, 1818, and the name adopted at that time.

When the Institution was founded the military engineer was in the ascendency. The growing importance of the engineer in other than military uses, however, incited the movement to gather in an organization persons practicing the profession in civil life. Therefore the Institution was founded at a meeting held in Jan. 2, 1818, in the Kendal Coffee House in Fleet St.

At that meeting Henry Robinson Palmer spoke on the urgent need of a source of information and instruction for persons practicing civil engineering. He laid stress on the advantages to be obtained from free interchange of opinion based on experience and from the application of scientific principles to working conditions. He placed the engineer as a mediator between the philosopher and the mechanic. He showed a balanced judgment on the relations of the three and gave due credit to the part of the mechanic; in fact, he enunciated the "teamwork" principle. The object of the Institution as defined by the founders was that of "facilitating the acquirement of knowledge necessary in the civil engineering profession and for promoting mechanical philosophy." The first resolution of a number that were offered by Palmer was "that a society be formed consisting of persons studying the profession of a civil engineer." Eight young men were present at this meeting and each subscribed a guinea ($5).

It was soon found that it was one thing to start a society and quite another to maintain interest and enthusiasm in it. This is indicated in the minutes under several dates in 1819 by the entry, "Not sufficient members present to form a meeting." Therefore a resolution was passed on Feb. 3, 1820, "That a respectful communication be made to Thomas Telford, Esq., F.R.S.E., civil engineer, requesting him to patronize the Institution by taking on himself the office of president of the same." So little was known of the Institution at that time that this was the first intimation Telford had received of its existence. Fully realizing the value of an institution of this character, however, he accepted the presidency without hesitation and was installed on March 21, 1820.

Telford's name gave the Institution the impulse it needed and his own efforts helped so greatly that on June 3, 1828, the Institution received a royal charter of incorporation under the Great Seal by the title, "The Institution of Civil Engineers."

As stated before, the term civil engineer in Britain, as in France, is used to create a distinction from the military engineer, who is concerned with fortifications, artillery and other means of defense and attack. It is believed that Smeaton, the designer and constructor of the Eddystone lighthouse, a beautiful piece of dovetail masonry work, was the first of the profession to call himself an engineer with the prefix "civil" to distinguish his profession from that of the military engineer.

The well-known definition of the profession of a civil engineer set forth in the royal charter is "the art of directing the great sources of power in Nature for the use and convenience of man." This definition is frequently attributed to Telford, but actually the description was drawn by Thomas Tredgold, who further pointed out that "the scope and utility of civil engineering will be increased with every discovery in philosophy, and its resources with every invention in mechanical or chemical science."

How clear his vision was the past century has demonstrated. One hundred years ago there were no tunnels under the Thames or under the Hudson and East rivers. The Thames tunnel, designed and constructed by Sir Marc Isambard Brunel, was opened officially on March 25, 1843. Toward the end of the century the completion of the tunnel beneath the Hudson River, under the direction of Sir Benjamin Baker, was effected. The resident engineer in charge of this work also constructed the Blackwall tunnel under the Thames, and the four railroad tunnels under the East River, New York. He is now Sir E. W. Moir, Bart., M. Inst. C. E., Fellow of University College, Officier de la Légion d'Honneur and a partner with Lord Cowdray in the firm of S. Pearson & Son, Ltd.

One hundred years ago the ocean steamship had yet to come. The United States, having done pioneer work on the Hudson and on Lake Champlain, built and equipped the "Savannah," a vessel with auxiliary steam power, which in 1818 made the voyage from New York to Liverpool partly under steam. It was not until 1838, however, that the American steamship "Sirius" made the trip from Cork to New York, arriving on the same day that the paddle steamer "Great Western,"

designed by Isambard Kingdom Brunel, completed the trip from Bristol to New York. The "Great Britain," screw propelled, also designed by Brunel, made her first outward voyage in 1845. Isambard Brunel was the son of Marc Brunel and had assisted his father in the building of the Thames River tunnel. The son was made a Fellow of the Royal Society in 1830 when he was twenty years old, and he was also a member of the Institution of Civil Engineers. It is interesting to note that, although he was a member of many societies, his biographer states that "he rarely attended any meetings except those of the Institution of Civil Engineers."

One hundred years ago there were no railways in Britain except the Stockton & Darlington Railway, about 12 miles long, which began operation in 1825. In 1825 also the bill for the construction of a railroad from Liverpool to Manchester came before Parliament, but the road was not publicly opened until Sept. 15, 1830. Railroad engineering at first involved arranging easy gradients and making tunnels through hills. Later it also involved tunneling under rivers and towns. The early works of this kind had to be done by human labor entirely, machinery for the purpose not being invented until later in the century under consideration.

One hundred years ago there were no street railways, no motor road transport, no telegraphs, no telephones, no electric supply stations, no submarines, no airplanes. Standardization was not thought of, research was unknown and the organized effort to obtain from the unknown the ground on which advance can be made was not even a dream.

Perusal of the long list of names of distinguished men who have filled the presidential chair of the Institution of Civil Engineers brings to mind the great and long-lasting works by which others will know them:

The Menai suspension bridge and the Holyhead road, the road from London to Ireland, recall Thomas Telford, president in 1820.

The Britannia tubular railway bridge brings to mind Robert Stephenson, president in 1855.

The Saltash bridge is a monument to Isambard Kingdom Brunel, who but for failing health would have succeeded Stephenson as president.

The Severn tunnel, 4½ miles long, is a reminder of Sir John Hawkshaw, president in 1861; John Clarke Hawkshaw, president in 1902, and Harrison Hayter, president in 1892.

The Mersey railway tunnel, which took six years to construct, was designed by Sir James Brunless, president in 1882, and Sir Douglas Fox, president in 1899.

The great water-works of England claim several presidents as their constructors, particularly Thomas Hawksley, president in 1871, and great harbors recall Sir John Coode, president in 1889.

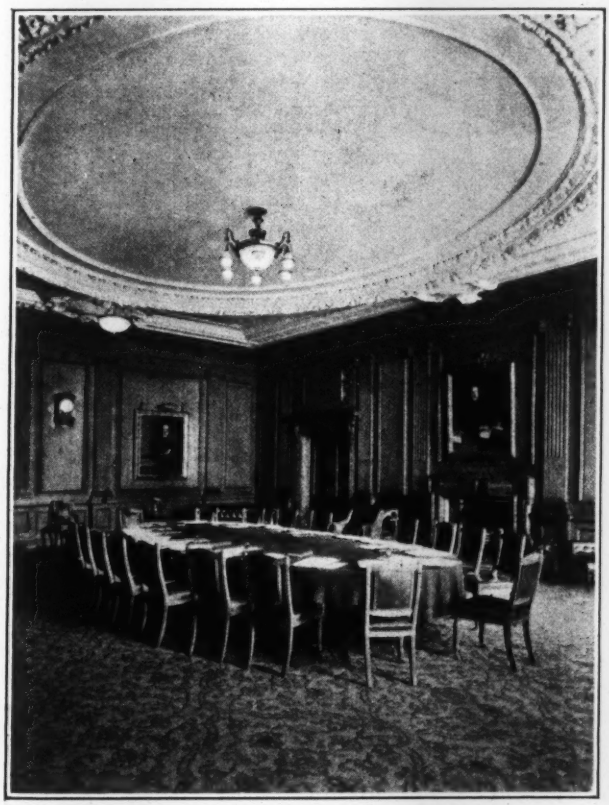
Many of the railways of Europe were designed by British engineers, particularly by C. B. Vignoles, president in 1869, who was the inventor of the flat-bottomed rail used practically everywhere except in England and on parts of the French Orleans and Etat lines.

The railways of India were largely created by J. M. Rendel, president in 1851; Sir C. H. Gregory, president in 1869; Sir George Barclay Bruce, president in 1887, and Sir Guilford Molesworth, president in 1904.

The Forth bridge is the work of Sir John Fowler, president in 1865, and Sir Benjamin Baker, president in 1895.

The great changes in naval construction between 1855 and 1902 were due to Sir William White, president in 1902.

Development of engineering education is represented by Sir Alexander Kennedy, president in 1906, and to Dr. W. Cawthorne Unwin, president in 1911. Both of these great teachers and great engineers have the affectionate regard and thanks of all who have studied under their guidance and tuition.



COUNCIL ROOM OF THE INSTITUTION OF CIVIL ENGINEERS

Since the charter for the Institution of Civil Engineers was drawn up the range of civil engineering practice has grown to comprise works for:

1. Facilitating and improving internal communications—roads, bridges, railways, tramways, canal and river navigation and telegraphs.
2. Coast defenses against the sea, communication between sea and land, harbors, docks, piers, breakwaters, seawalls and lighthouses.
3. Communications across the sea—naval architecture, metal shipbuilding, construction and laying of submarine cables.
4. Reclamation, irrigation and drainage of land, prevention or regulation of floods.
5. Water supply, sewage disposal, lighting and street improvements.
6. Large buildings—their scientific and mechanical arrangements.
7. Operations in mining and metallurgy involving the application of mechanical science.
8. Mechanical prime movers, steam engines, waterwheels and other hydraulic motors, windmills, electric and other motors.
9. The design, construction and application to practical use of all kinds of machinery and mechanical appliances.
10. The design and manufacture generally of large and important metallic structures, including artillery and other large munitions of war.

The list could obviously be greatly expanded to include power stations, submarines, airdromes, airships, airplanes, wireless stations, and work carried out in the new constructional alloys or compositions.

As the scope of the civil engineer expanded the Institution grew in membership and influence. In 1820 its home was at 15 Buckingham St., Adelphi, in rented rooms. In 1834 a house was taken at 1 Cannon Row, Westminster, and four years later the Institution moved

to 25 Great George St., which served, with alterations and enlargements made in 1846, as the home of the Institution until 1868, when further enlargements were made and the back portion of No. 24 was added.

Increased membership, large attendance at the meetings and the growth of the library brought the question of accommodations to the front once more in 1894. A supplemental charter was obtained to enlarge the Institution's power to hold land from an annual value of £1,000 to £8,000 and a new building was constructed. This building was relinquished to the government in 1912 and a new site was obtained on the south side of the street, on which the present home of the Institution was erected. With the land on which it stands, its present capital value is £352,000 ($1,720,000), all of which with the exception of a small amount which will be extinguished in a decade, has been contributed by the members past and present.

This building contains a lecture room capable of seating 300 persons; a library containing 54,000 books and a great wealth of documents, drawings, manuscripts and autograph letters relating to early civil engineering work unrecorded or incompletely described in books or other publications; the grand hall, measuring 100x45 ft. and 45 ft. high, which is used for large conferences; a central hall, and council room.

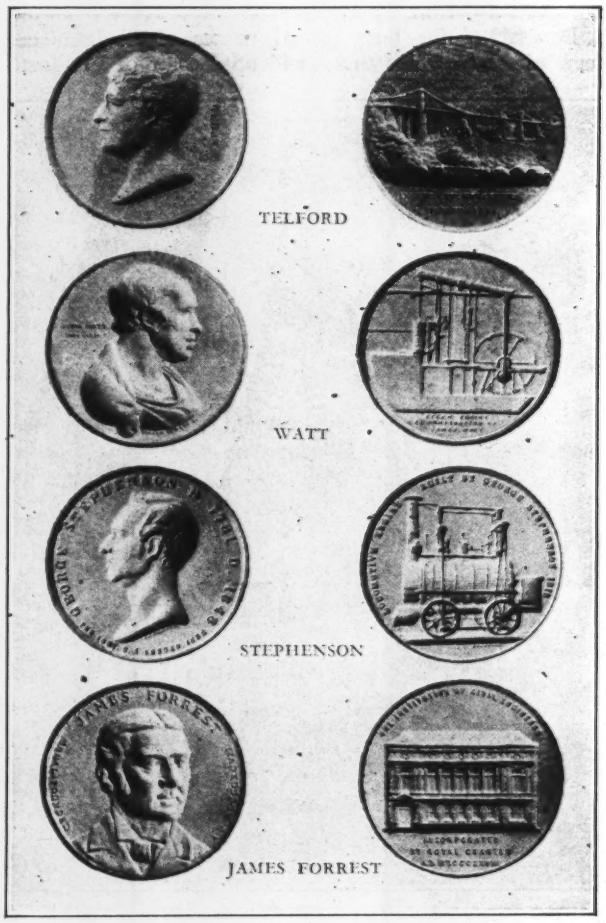
From the first a high standard was required of the membership. The first constitution, which provided for the election of members and honorary members, also provided for the ejectment of any member "careless about the interests of the society." In 1819 a class of corresponding members was added, and in 1820 a class of associates was formed. In 1837 the corresponding members were merged in the ordinary members, a distinction being made between residents and non-residents, and a class of graduate members was established consisting of "persons pursuing a course of study or employment in order to qualify themselves for following the profession of a civil engineer." At the same time a minimum age for membership was fixed at 25 years; no limit of age was set for graduates. In 1846 the corporate privilege of voting at meetings was withdrawn from the graduates and no further elections were made to this class. Young engineers were then admitted as associates, but the mixture of young professional members with original associates, who were not engineers by profession but whose work was beneficial to the profession, was not satisfactory. In 1878 a junior class of corporate members styled "associate members" was established. Meanwhile, in 1867, another class had been established, of "students," to enable young men of 18 to 25 years of age, who were preparing themselves for the engineering profession, to enjoy many advantages of association with the Institution, but without corporate rights. This constitution continues at the present time. The membership roll has increased continuously from 100 in 1826 to 10,210 in May, 1928.

The influence of the Institution on its membership is very great, particularly in fixing high standards of professional knowledge and conduct. For admission to the graduate class and again to that of associate membership, the candidate must pass examinations of considerable severity in a large number of subjects, the alternatives being the science degree of certain universities or waiting until about 40 years of age and judgment by the council on the degree of eminence in the profession attained by the candidate. For this reason the authorized abbreviations, "M. Inst. C. E." for member and "A. M. Inst. C. E." for associate member, are used exclusively by the respective classes. The standards of professional conduct in the Institution are high and expulsions low. These widely known facts give weight to the evidence that may be given by members before royal commissions, parliamentary committees and in the higher courts of law.

Among its other activities the Institution has appointed committees to deal with questions that required consideration. Of these, engineering education in the British Dominions was very important and led to other committees being appointed to deal with training and with examinations.

The committees of investigation did great service by their reports on the "Thermal Efficiency of Steam Engines," and, later, on "Tabulating the Results of Heat Engine Trials." Other reports dealt with reinforced concrete, followed by another undertaking in 1916, with the assistance of the government—an inquiry into the deterioration of structures of timber, metal and concrete when exposed to the action of sea water. The Institution has in other instances, such as the National Physical Laboratory, given liberal support for researches on wind pressure, alternating stresses and welded joints.

One of the greatest undertakings was that inaugurated by Sir John Wolfe Barry, a work of the highest industrial importance—that of the body now known as the British Engineering Standards Association. The



MEDALS AWARD BY THE INSTITUTION

present permanent committee includes the co-operation of the Institution of Mechanical Engineers and the Institution of Electrical Engineers, as well as the Institution of Naval Architects and the Iron and Steel Institute.

From this work of ever-widening scope I pass to the mere mention of the benevolent fund, a fund that has in the last 64 years expended £215,000 ($1,000,000) in assistance to dependents of deceased or distressed members, a fund that has always been administered with human consideration and privacy.

Court Holds City Responsible for Reservoir Failure

State Supreme Court Decides Against Seattle in Boxley Canyon Flood Caused by Failure in Cedar Falls Reservoir

ON DEC. 23, 1918, extensive property damage resulted from a flood in Boxley Canyon near Cedar Falls reservoir, constructed by the city of Seattle, Wash., for municipal water supply and power purposes. The North Bend Lumber Company sued the city for damages shortly after the disaster and a series of suits have dragged on through the intervening years to a decision adverse to the city recently handed down by the State Supreme Court in Washington, sustaining a verdict of $336,945.80 rendered by a jury in the Pierce County Court in 1927.

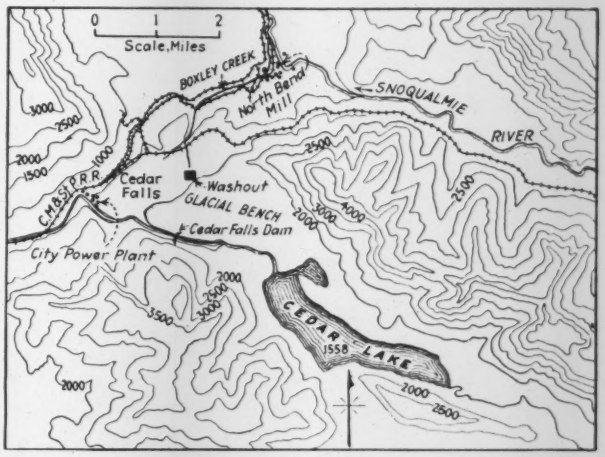
The Cedar River dam is a concrete structure of gravity section, arched in plan, approximately 200 ft. high in the maximum section and having a crest length of about 1,000 ft. (*Engineering Record*, April 10, 1915, p. 471.) It is situated in King County about 40 miles southeast of Seattle on Cedar River, a tributary of Snoqualmie River, near North Bend, Wash., and about 1 mile west of the point where the river leaves Cedar Lake. The dam had not been completed, but storage in the reservoir had begun and the water level had been raised materially when the flood occurred in Boxley Creek.

Boxley Creek, also a tributary of the Snoqualmie River, drains a small watershed to the north of the lower portion of the Cedar River basin. The summit between the Cedar and the Boxley watersheds is a glacial bench, approximately a mile wide. A washout and slide on the Boxley basin side of this summit marked the first visible evidence of the flood that swept down the stream below.

After the flood a suit was filed by the North Bend Lumber Company, claiming $360,000 damages on the ground that the flood resulted from water impounded in the reservoir behind the Cedar River dam; that this water, by seepage and percolation, passed through approximately 1 mile of glacial moraine on the right bank of the reservoir and broke out at the head of Boxley Creek. The lumber company further contended that the rising of water in Rattlesnake Lake situated below and to the west of Cedar River was evidence that the impounded water behind the dam was the source of trouble and was responsible for the damage caused to the lumber property.

The city contended, on the other hand, that the water impounded behind the dam was in nowise responsible for the occurrence; that Rattlesnake Lake had a history of rapid rises as far back as 1852; that the breaking out of the water causing the damage occurred in the north lateral moraine of the Cedar River glacier; that the north lateral moraine was connected directly with Cedar Lake, more than a mile from the Cedar River dam; that the lake in times past, before the erection of Cedar River dam, had risen to a considerably higher elevation than at the time of the alleged damages, and that there was an impervious stratum separating the north lateral moraine from the impounded waters of the pool.

In the first decision the finding was in favor of the city, but in two subsequent cases of the Chicago, Milwaukee and St. Paul Railway against the city involving the same state of facts the juries failed to agree. The county court decision against the city was rendered in Pierce County, March 14, 1927, after a change of venue from King County, in which Seattle is situated, and was sustained by the State Supreme Court as noted. The trial judge interpreted for the jury that waters impounded by the masonry dam included all the waters of Cedar Lake whenever the waters of the impounding



RELATIVE LOCATION OF RESERVOIR AND BOXLEY CREEK
Flood in creek follows lake rise caused by new dam.

basin behind the dam had risen to the height of the lake outlet.

By way of reference to the court procedure the following citations are given:

First case, King County Court, Seattle, North Bend Lumber Company vs. Seattle, December, 1919. Verdict in favor of the city. Reversed, May, 1920, on account of an erroneous instruction upon the question of contributary negligence.

Second case, federal court, Seattle, director general of railways, Chicago, Milwaukee & St. Paul Railway, vs. Seattle, January, 1922. For damages alleged to have occurred to the railway caused by the washout and the same state of facts. Jury disagreed.

Third case, federal court, Seattle, director general of railways, Chicago, Milwaukee & St. Paul Railway, vs. Seattle, January, 1923. Retrial of second case. Jury disagreed.

Fourth case, Pierce County Court, Tacoma. North Bend Lumber Company vs. Seattle, January, 1927. Retrial of first case. Decision against city; sustained by State Supreme Court.

Open-Web Floor Joist Construction in 42-Story Building

Grant Building in Pittsburgh Includes a Five-Story Basement Garage—Open-Web Bar Joists Welded to Floor Beams

THE NEW Grant Building, under construction in Pittsburgh, Pa., is a 42-story steel-and-concrete office structure. It is unique in that in addition to its 37 stories of structural steel above the street, it has five stories of steel and reinforced concrete below street level to be used as a garage. An additional feature of the structure is its use of open-web bar joists welded to the floor beams of all floors above the street. The building has a frontage of 171 ft. 9½ in. on Grant St., a depth of 100 ft. 2½ in. on Fourth Ave. and a depth of 127 ft. 1⅝ in. on Third Ave.

The excavation for the building passes through about 10 ft. of earth, 20 ft. of sandstone and 20 ft. of shale to the fifth basement floor level. Seventy-two column footings of concrete are taken about 25 ft. below this to a hard sandstone foundation 90 ft. below grade. Bearing pressure was assumed at 25 tons per square foot.

Rolled-section columns weighing 425 lb. per foot and reinforced with cover plates are used in conjunction with wide-flanged beams. For design purposes a wind pressure of 15 lb. per square foot was assumed.

All floors are divided into panels ranging in size from about 18x19 ft. to 19x26½ ft. The first floor and first to fourth basement floors inclusive are of reinforced concrete poured on metal forms. The fifth basement floor of concrete rests upon the shale at the bottom of the excavation.

Above street level all floors are carried on open-web bar joists spaced from 18 to 24 in. Each joist is welded to its supporting beams on both sides by welds ¾ in. long. In order to assure a more rigid floor construction and to assist in distributing concentrated loads, a 3-in. I-beam cross-joist has been placed on the center line of each panel, bolted to each bar joist and welded on both ends to the floor beams. Wire bridging is also used at the quarter points of the span. On top of the bar joists and clipped to them is metal lath weighing 4¼ lb. per square yard. A 3-in. concrete floor is used, further reinforced with wire mesh.

FIG. 1—ARCHITECT'S DRAWING OF GRANT BUILDING, PITTSBURGH, PA.

The bar joists are small Warren-type trusses, with top and bottom chords of wide tee-shaped members. The bottom chord is continuous to the bearings, where it is welded to a web plate and this to the top chord to form an I-section.

The web members, of round rods, are continuous from end to end of each truss, being welded to the chords. This type of floor construction was chosen for its light dead weight and for the advantages it offered in installing pipes and conduits between the upper and lower chords.

Welding the bar joists to the floor beams is a new departure. Previously such joists have been attached to the beams by means of clips, which serve only as a temporary attachment until the metal lath and concrete are in place. It is believed that by the use of this welded connection and the utilization of cross-joists a considerable stiffness will be added to the whole structure, since each panel will act as a slab. The building contains about 6,000 tons of structural steel. The engineers believe that it repre-

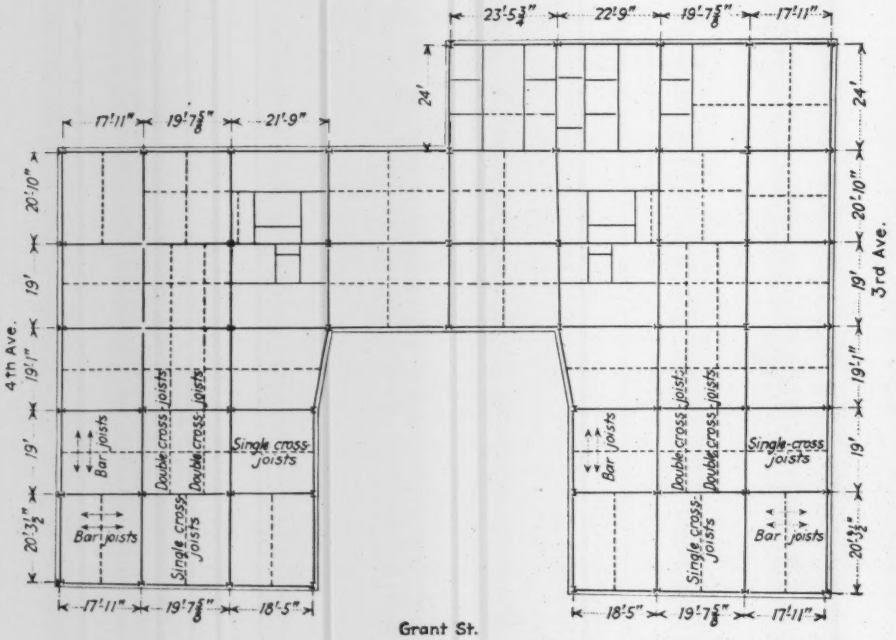


FIG. 2—STRUCTURAL FRAMING, GRANT BUILDING, PITTSBURGH

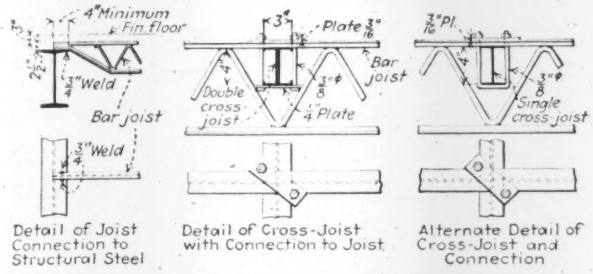


FIG. 3—DETAILS OF TYPICAL FLOOR FRAMING

Chords of bar joists are wide sections welded to floor beams so that each panel will act as a slab. Note continuous bottom chord and web.

sents a saving of about 15 per cent over the usual framed floor construction.

The garage in the basement is designed to permit rapid and unobstructed movement of vehicles into and out of the building by means of staggering the floors and connecting them at each end by a pair of concentric curved ramps. The garage is mechanically ventilated by means of two sets of blowers, one supplying air from around the exterior walls and the other exhausting the gases from the center. A complete change of air every six minutes is provided for. The first floor of the building is for banks and stores, while all other floors are arranged for offices. The heating system of the building is divided into 24 zones, permitting an economical use of steam. Fourteen high-speed elevators are used.

The architect of the building is H. Hornbostel, who, with W. J. Strassburger, holds a patent for the garage system. M. Neumann was the structural engineer on the building, and the Thompson-Starrett Company the general contractor. Eric Fisher Wood & Company acted as associate architects.

FIG. 4—42-STORY BUILDING IN PITTSBURGH WITH OPEN-WEB JOIST FLOORS UNDER CONSTRUCTION

Chemical Handling and Control of the Baltimore Filters

Alum Made From Bauxite and Lime Used to Reduce CO_2 at New Montebello Filters—Automatic Control for These and Chlorine

By James W. Armstrong
Filtration Engineer, Bureau of Water Supply, Baltimore, Md.

MONTEBELLO filters are located about 2 miles from a railroad and all chemicals for the new plant are hauled in a truck, weighed and dumped into a receiving hopper. The new plant is adjacent to the old one, but is separately housed. The new plant has a rated capacity of 128 m.g.d. and the old one of 112 m.g.d.

Alum is used as a coagulant and is manufactured at the plant. The bauxite for making alum is received from Arkansas in carload lots in bulk, and is fed from a receiving hopper by an automatic feed device into a Raymond pulverizer, which reduces it to a fineness of from 80 to 200 meshes per inch. The bauxite is exhausted from the pulverizer by a large 24-in. fan and is discharged through a cyclone collector into a spiral conveyor near the top of the building. From the conveyor, bauxite can be passed through spouts into any one of a number of large concrete storage bins. Brimstone sulphuric acid, 60 deg. Bé., is bought in the local market, hauled to the plant in a tank trailer and after weighing is discharged by gravity into large unlined steel storage tanks located in the basement. Common black iron pipe is used for conveying sulphuric acid and cast-iron pipe for alum solutions. The only lead pipe used in the plant is for conveying dilute acid. All machinery is operated by electric motors and is stopped and started by means of push buttons located at convenient points.

When it is desired to mix a batch of alum, the acid is lifted from storage tanks in the basement by means of a Labour centrifugal acid pump and discharged into a measuring tank, located on the top floor of the building immediately above the boiling tanks. After the amount of acid for a single batch has been measured, it is discharged into the boiling tanks and slightly diluted.

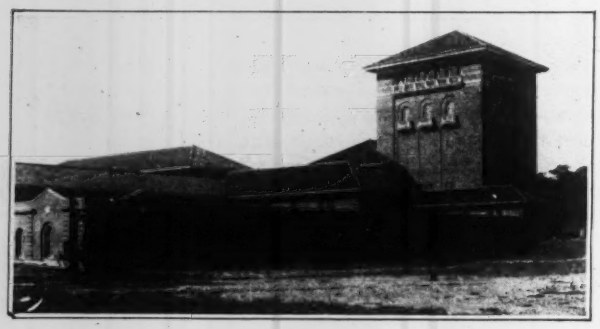
The bauxite is withdrawn from the bottom of the storage bin into a spiral conveyor, which discharges into a weighing hopper suspended directly over the boiling tanks, which are made of steel and lined with lead. The amount entering the hopper is indicated by a Toledo scale having a large dial facing the operator. The bauxite is slowly admitted to the boiling tanks and the chemical reaction between the acid and bauxite is carefully watched. Should the agitation become too violent, a little additional water is admitted to the tank. After the reaction is complete, the alum is diluted to the required strength for application to the water. The chemical feed controllers are located beneath the boiling tanks and are constructed of concrete, 6 ft. square, and are coated inside with bitumastic enamel.

The solution is maintained at a constant level in the tanks by means of a float-actuated pinch valve. The float is unusually large and exerts a very positive pressure in opening or closing the valve. The alum solution flows from the solution tanks through a large hard rubber nozzle that is set parallel to the face of the tank and revolves about the tank outlet as a center. The discharge from the nozzle is regulated by a device like that used for

controlling the discharge from a Pelton waterwheel nozzle. The nozzle outlet is maintained at a distance below the surface of the solution in the feed tanks that corresponds exactly to the meter differential, and the position of the nozzle outlet is regulated by a mechanism actuated by the Venturi meter floats.

It can thus be seen that the chemical control is automatic and that the flow is directly proportional to the volume passing through the meter. When both the old and the new plants are in operation, automatic control becomes a necessity, as there will be no way of maintaining a definite rate of flow to each plant.

Milk of lime is added to the filtered water to reduce the CO_2 and prevent pipe corrosion. Lime coming to the plant is passed through a rotary crusher and reduced



VIEW OF NEW FILTER HOUSE, BALTIMORE WATER-WORKS

Rated capacity of new filters, 128 m.g.d., which, with the first installation, gives a total capacity of 240 m.g.d.

to a maximum of about $\frac{3}{4}$ in. in greatest dimension. The lime is then automatically fed into a short spiral conveyor and in turn into a bucket elevator, which lifts it to the top of the tower, from where it is spouted into the storage bins. The machinery is designed in such a way that the conveyor has a greater capacity than the crusher and the bucket elevator a greater capacity than the conveyor. Automatic control devices are provided, which in event of an accident to the elevator or conveyor would stop the crusher motor and thus prevent the choking of the system. The lime is admitted from the storage bins to a spiral conveyor that discharges into hoppers, which are suspended directly above the lime slakers. The slakers are something like concrete mixers except that they are much larger in diameter and are provided with stationary feed devices and a door to prevent slopping during the mixing period. The slaked lime is admitted to an open trough, from which it passes into the solution tanks through screened openings. The lime solution tanks are rectangular in plan and are built of concrete. The solution is agitated by means of a slow revolving paddle actuated by motors and gearing from the top. Square or rectangular tanks give much better agitation than round tanks, due to the fact that the eddying in the corners prevents the mass of liquid from revolving with the blades. The lime controllers are similar to those used for alum. A Leeds & Northrup pH machine is used for determining the amount of lime to be applied.

The chlorinators are located on the second floor of the building in a room independent from the cylinder room. A large glass window between the two rooms permits the scale dials, which are of a Toledo type with double face, to be read from either room. The cylinder scales are 16 in. wide and 8 ft. long and are set flush with the floor. An exhaust fan has been installed in the cylinder room so that in case of an accident the gas can be removed before the operator goes into the room. The chlorine can be applied either to the filtered water leaving the plant or to the treated water entering the mixing basin by simply changing the outlet connection. The control is automatic for the same reason that it is necessary to apply the alum automatically.

Proportioning Concrete Mixes for the Coolidge Dam

Keeping Consistency Constant, a Straight-Line Variation Is Found Between Mortar Strength and Cement Content

By Bruce Johnston

U. S. Indian Irrigation Service, San Carlos, Ariz.

WORKING out ideal concrete mixes under the specification requirements and conditions obtaining at the Coolidge multiple dome dam in Arizona presented opportunity to study certain fundamental proportioning problems. Having found the best grading of the aggregate and the minimum amount of water to give the desired workability, the question arose as to how low the cement content could be and still give the required strength. This is not simply a matter of consulting the strength-water cement ratio curve, because each brand of cement is likely to result in a different relation. At Coolidge dam a strength relation was worked out in which the consistency of the concrete was kept constant and the proportion of cement to the total aggregate was varied. The curve plotting these relations gives directly the lowest quantity of cement for concrete of the desired consistency, workability and strength.

Sand and gravel for the Coolidge dam are taken from a large bar in the Gila River, half a mile below the dam. Oversize rock is crushed and all aggregate is screened and washed in a well-equipped plant. Crushed rock and gravel are segregated into the following grades: $\frac{5}{16}$ to $\frac{3}{4}$ in., $\frac{3}{4}$ to $2\frac{1}{2}$ in., and $2\frac{1}{2}$ to 6 in. From stock piles at the screening plant the materials are delivered by tramway to the mixing plant at the dam, where separate bins are provided for each size.

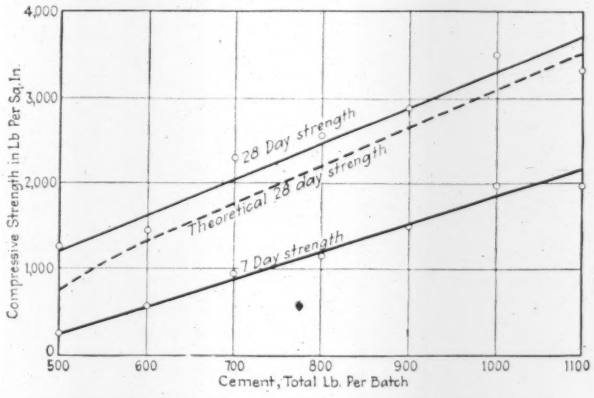
STRENGTHS FOR VARIOUS COMBINATIONS OF WATER AND CEMENT

No.	Batch Equivalent—Cement, Lb.	Sand, Cu.Ft.	Water-Cement Ratio	Compressive Strength, Lb. Per Sq.In. 7 Days	28 Days
1	500	26	1.72	300	1,260
2	600	26	1.45	500	1,430
3	700	26	1.27	950	2,300
4	800	26	1.15	1,000	2,540
5	900	26	1.05	1,500	2,860
6	1,000	26	0.98	1,910	3,500
7	1,100	26	0.91	1,910	3,320

The concrete mixers are fed by automatic batchers set to deliver the prescribed volume of sand and the three grades of coarse aggregate. Cement is measured by an automatic weighing batcher. Water is not measured directly, but the consistency of the concrete is rigidly controlled, both at the mixer plant and on the dam, by careful inspection and frequent slump tests. Each batch is mixed for two minutes and yields approximately 2.3 yd. of concrete. Delivery from the mixers to the dam is by means of chuting systems and hoisting tower.

Two classes of concrete are being made: Class A, for the domes, specifies a 28-day strength of 2,200 lb. per sq.in.; Class B, for the buttresses, specifies a 28-day strength of 1,800 lb. per sq.in. When the work began, 940 and 846 lb. of cement per batch were used in Class A and Class B concrete, respectively. Now the corresponding cement quantities are 900 and 800 lb., respectively. This works out as 1 bbl. of cement per cubic yard of concrete in place for Class A concrete and 0.9 bbl. per cubic yard for Class B concrete.

The same quantities of aggregate per batch are used in both dome and buttress concrete. In designing the mixes, several well-known methods were used, attention being directed particularly to obtaining a uniform grading of all aggregate. The grading has been carefully



RELATION BETWEEN MORTAR STRENGTH AND CEMENT CONTENT

controlled and checked by frequent screen analyses of both sand and rock. Segregating the rock into three classes greatly facilitates the control of the mix and has made possible very consistent and uniform results.

The reduction in the cement content referred to in the foregoing was made while still keeping the strengths above those required by the specifications. Having effected this saving, a series of tests was undertaken to determine just how low the cement content might go, theoretically, and these tests agreed very closely with the results of actual tests made on the job.

An underlying assumption in these tests is that the compressive strength of concrete is practically the same as the compressive strength of the mortar with which it is made, an assumption that was checked by the tests. A series of 2x4-in. mortar cylinders was made, in which the cement content was varied while the consistency of the mortar was kept constant at the point that would give the 5-in. slump allowable in concrete going into the dam. To determine the water-cement ratio that would give this slump, actual samples were mixed in which the total aggregate proportions were the same as in the concrete used in the structure.

Each mortar sample was made to correspond to job concrete in which the cement content per batch varied from 500 to 1,100 lb. The water-cement ratio was varied in each case to give a constant consistency throughout the series. The results of these tests are plotted in the accompanying graph, in which it is to be noted that there is a straight-line relation between mortar strength and cement content when the consistency is kept constant. If the strength be plotted against the water-cement ratio, the usual curve will result. The straight-line relation is particularly useful in proportioning large batches where the quantity of cement and aggregate is accurately controlled by batchers and may be varied in any degree.

Where varying concrete strengths are specified for different parts of a structure, as is often the case, it may be very convenient to have the proportioning and quantity of the aggregate, as measured by the batcher, fixed at a definite amount, controlling the strength by varying the cement content.

The agreement on the Coolidge dam job between mortar strength and job concrete strength is striking. The average 28-day strength of concrete poured up to the time this article was written was 3,150 lb. per sq.in. for Class A concrete and 2,480 lb. per sq.in. for Class B concrete. The mortar strength curve gives a 28-day strength of 2,900 lb. per sq.in. for Class A and 2,450 lb. for Class B.

Although both actual results and theoretical considerations have indicated that a still further reduction in cement content might be made within the strength limitations, a study of density and corresponding impermeability has indicated the desirability of using not less than 900 lb. of cement per batch in the dome concrete. In any case, dealing with the practical application of the findings outlined in the foregoing, it would be well to add a percentage of cement to take care of fluctuating conditions of pouring, curing and quality of materials.

Autos Rank With Deadliest Diseases

In Illinois, for the year ended March 3, 1928, automobile fatalities were exceeded by the deaths from only nine of nearly 200 diseases. In a state board of health analysis the statement is made that 1,776 deaths were caused, a number greater than the deaths from diphtheria, infantile paralysis, malaria, measles, smallpox, typhoid fever and whooping cough combined. More than half of the deaths resulted from automobiles running down pedestrians. Collision between automobiles, including trucks, is the next frequent cause of death.

DEATHS IN ILLINOIS IN 1927 IN WHICH AUTOMOBILES WERE CONCERNED

Analysis of Contributing Factors*	Chicago City	State Excl. of Chicago	Total
Total deaths	864	912	1776
Pedestrians struck	637	326	963
Collisions between automobiles	76	161	237
Automobiles struck by trains	11	141	152
Automobiles struck by street or electric cars	29	33	62
Collisions with horse-drawn vehicles	2	7	9
Collisions with fixed objects	22	37	59
Collisions with motorcycles	4	13	17
Collisions with bicycles	1	6	7
Crushed between automobiles and fixed objects	10	4	14
Cuts on windshields, broken necks, etc., in running autos	1	5	6
Gas asphyxiations	23	17	40
Deaths by fire	2	11	13
Deaths by drowning	2	8	10
Persons run over by or crushed under automobiles	85	79	164
Persons falling from running automobiles	32	54	86
Overturned automobiles	11	120	131
Speeding automobiles	1	9	10
Skidding automobiles	6	28	34
Deaths from premature birth caused by auto accidents	0	6	6
Explosion of tires	1	2	3
Cranking automobiles	3	4	7
Deaths from gas explosion	1	4	5
Defective brakes	0	0	1
Bright lights	0	3	3
Miscarriage—death of mother	0	1	1
Tetanus	0	1	1
Taxicabs involved	71	15	86
Trucks involved	139	105	244
Intoxication	1	4	5
Broken wheel	2	0	2
Repairing tire	2	3	5
Gun shot, revolver discharged while cranking auto	0	1	1

* Several contributing factors are often involved in an automobile death. A single death may therefore be included in several items of the above analysis.

From Job and Office

Hints That Cut Cost and Time for the Contractor and Engineer

Cheap Removal of Concrete End Walls

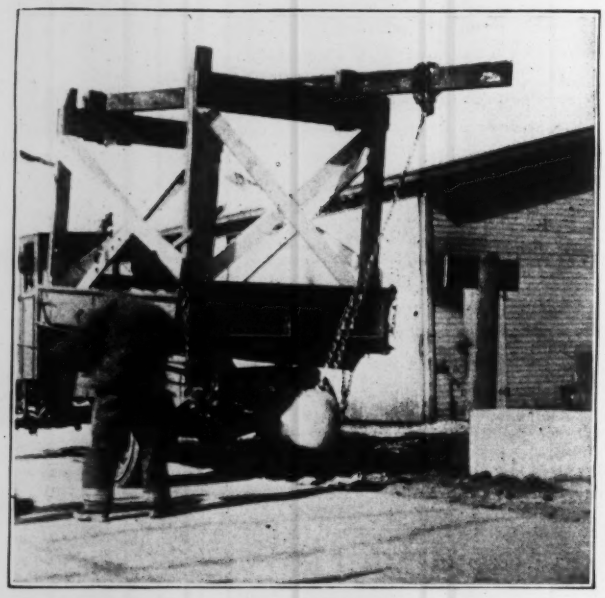
By J. A. Stransky

Division Engineer, Wisconsin Highway Commission

WHEN the Wisconsin Highway Commission issued orders for the removal of culvert end walls, Milwaukee County was confronted with the problem of removing them from 710 culverts and 70 small spans on 220 miles of state and county trunk highways. *Badger Highways*, the official organ of the commission, tells of the method developed to do this cheaply and efficiently.

As it was desired to complete the task in a short time, six air compressors, with necessary equipment, were pressed into service. It was found, however, that by ordinary methods each compressor would demolish only three end walls per day at a prohibitive cost averaging $15 per wall. Joseph Schmidler, superintendent in charge of the work, developed a method of demolition by battering which gave excellent results. A heavy framework of 4x6-in. timbers with sway bracing of 2x6-in. plank was built inside the body of a motor truck, as shown in the illustration. All members were securely bolted together, and also bolted to the front and rear gates of the body to secure rigidity. A 6x8-in. diagonal timber, securely blocked, was bolted across the top of the framework, extending beyond the right rear of the body about 14 ft. above the ground. From this timber a cast-iron ball weighing 1,250 lb. was suspended by a heavy chain. The angle of this diagonal member was such that when the truck was driven alongside of a culvert end wall the suspended weight was very nearly in contact with the wall.

Four men, by pulling on a rope, caused this ball to swing as a pendulum and, acting as a hammer, this moving weight shattered the concrete. This was kept up until the wall was demolished. Reinforcing steel, when exposed, was cut with a hardie, although a torch could have been used to good advantage. After demolition had taken place, the rough tops were trimmed with air chisels, although in a great number of cases breakage was uniform and this was unnecessary.



SWINGING IRON BALL PROVIDES EFFECTIVE METHOD OF REMOVING CONCRETE END WALLS

The weight was set so as to deliver the first blows 6 to 8 in. from the top, it having been found that by so doing a line of cleavage would develop at the first horizontal reinforcing bar, usually about 12 in. from the top. The weight was lowered by raising the front end of the truck body until the ball rested on the ground and then lengthening the chain. It was found inadvisable to use the weight with the body in a raised position because of the unusual strains which were set up. An "A" frame was first used at the rear end but it could not be braced properly and, furthermore, it was found that considerable force was lost because of the arc in which the hammer traveled when it passed the center of the truck.

Contrary to general opinion, very few cracks have been developed in culvert barrels by the use of this outfit. A little experience soon showed in just what manner an endwall could best be removed. For example, for a culvert with an endwall which extended a considerable distance above the barrel opening, with little or no earth pressure to take up the shock, the truck was backed up so that the weight was on the outside of the end wall, and the blows were struck from the field side.

The cost and the time required for removing these end walls were far lower than was expected. In a little more than two months, by means of this simple but effective apparatus, 1,560 end walls have been removed at an average rate of 35 per day. The cost, including machinery rental, labor and supplies, was 98 cents for each end wall.

Checking Tunnel Size by Measurement From Wire Base Lines

By L. T. Sogard

Junior Engineer, Sanitary District of Chicago

CONSTRUCTION of Salt Creek intercepting sewer, Contract No. 2, of the Sanitary District of Chicago, involved driving 6,600 ft. through solid limestone for a 7x7-ft. gothic-arch type section. Shafts were sunk at half-mile intervals and the entire tunneling operations in the rock were completed at each shaft before any of the concrete lining was placed.

All points where the full required cross-section was not obtained during the blasting operations were left for trimming until after the heading had been holed through. Tight sections were then marked for trimming by the aid of the device shown in Fig. 1. The vertical rods were constructed of ¾-in. iron pipe, 6 ft. long. The upper end was closed and drawn to a point. A piece of ½-in. pipe, 5 ft. long, pointed at the lower

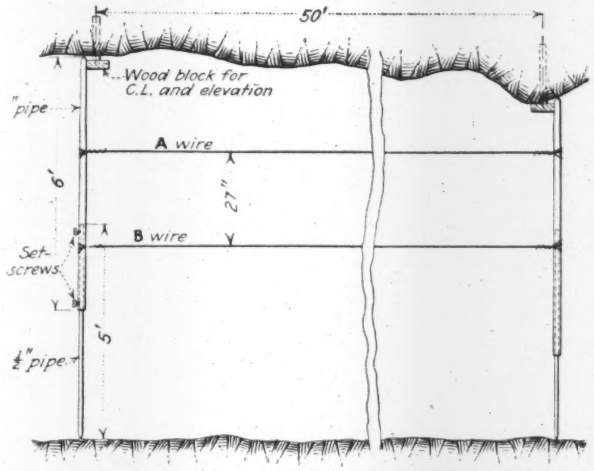


FIG. 1—HOW RODS AND WIRES ARE SET UP FOR CHECKING CROSS-SECTION OF TUNNEL

end, was slipped inside the ¾-in. pipe, making the length of the rod adjustable. Two setscrews in the ¾-in. pipe served to hold the smaller pipe at any desired position.

Center line, grade and stationing had been established during the tunneling operations at 50-ft. intervals on blocks attached to wooden plugs in the arch of the heading. At any two adjacent blocks the rods were set up vertically on the center line. A thrust of the pointed ends into the rock above and below helped to hold the rod in place after it had been set at the necessary length.

The required cross-section for excavation is shown in Fig. 2. Knowing the elevation of the block at which the rod was set and the required elevation of the arch at the same point, the distance down from the block to *A* was calculated. Computations for each block were all made in advance; when the rod was set at a particular block, the *A* point was immediately established by measuring down from the block. A wire was then stretched between the *A* points on the two rods. The *B* wire was set 27 in. below the *A* wire. Using a rule, the distance from the *A* wire to the arch was measured throughout the 50 ft. of the set-up. Any tight places, less than the required 20 in., were circled with red paint and labeled with the number of inches to be removed. The same process was followed by measuring horizontally from each side of the *A* and *B* wires, using the dimensions shown on Fig. 2. The simplicity of this device, which was developed by J. H. Richmond, assistant engineer of the Sanitary District, enables two men to measure up and mark about 200 ft. of tunnel per hour.

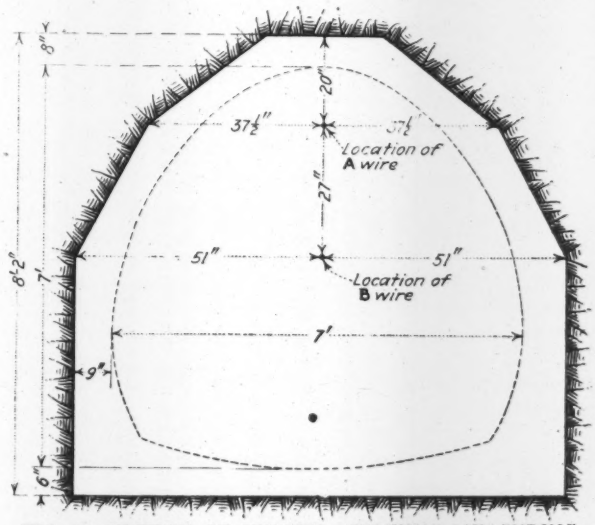


FIG. 2—SECTION OF TUNNEL, SHOWING MEASURING POINTS; DOTTED LINE INDICATES NEAT LINE OF CONCRETE LINING

Oxy-Electric Torch Cuts Steel Sheeting Under Water

OXY-ELECTRIC torches were used with success in cutting off a line of steel sheeting under water at the Albany Ave. bridge, Atlantic City, N. J. Combining the heat of the electric arc with oxygen under pressure, the torch burned easily through the steel and through wooden splines which had been driven into the interlocks to insure a watertight cofferdam. A specially constructed electrode on the torch directs a jet of oxygen onto the metal where the arc is acting. The oxygen blows the molten metal out of the cut as well as oxidizes it.

An average of fifteen piles per day was cut by a diver working on an easily moved scaffold hung on the face of the wall. A small motor generator on shore furnished the current, and oxygen was obtained from the usual portable tanks.

The information for this article was furnished by the Westinghouse Technical Press Service, East Pittsburgh, Pa.

120-Ft. Trusses Clear Garage of Posts

TWELVE bowstring trusses made of structural grade Douglas fir, each 120 ft. long, were used in the construction of the J. F. Hickey Motor Company garage in Tacoma, Wash., giving the building approximately 27,000 sq.ft. of floor space unbroken by posts. The lumber was selected and sawed for the purpose intended by a Tacoma mill that features production of special strength grades.

The building is 120x225 ft. The bottom of the lower chords is 12 ft. above the floor. The lateral braces are composed of 2x6-in. and 2x8-in. material. The struts in the chords are 4x6 in. Each truss contains approximately 2,700 ft. b.m. of lumber and weighs about 4½ tons. After the first two trusses were completed seven men were able to make the ten other trusses and put them in place in about nine hours each, using a hand hoist and a gin pole.

Construction of the building took about eight weeks. J. E. Bonnell & Son, Tacoma, were the general contractors. H. Steinseifer was superintendent of construction. The trusses were designed by the American Roof Truss Company and were built under the direction of Hector MacLane, truss builder.

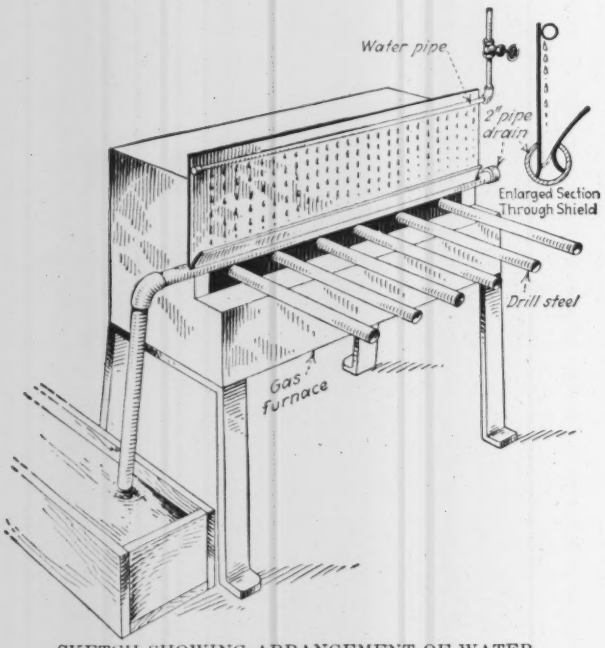
Water-Cooled Shield for Drill Steel Furnace

IN ORDER to reduce the discomfort of the blacksmith's helper due to heat radiated from a furnace in which drill steel is heated, a water-cooled screen was rigged up, as shown in the accompanying sketch, on the Diablo dam project in Washington.

The screen consists of a piece of scrap sheet metal about 18x30 in. in size, placed vertically in front of the furnace and supported at the bottom in a 2-in. pipe, along

the top of which a longitudinal slot was cut out with an acetylene torch. A water pipe passes along the top of the sheet metal and through holes drilled in this pipe at 2- or 3-in. intervals small streams of water spray down over the face of the metal sheet, thus cooling it and preventing the radiation of heat.

A smaller piece of sheet metal of equal length was inserted in the pipe slot, as shown in the enlarged detail sketch, to prevent any splashing of water upon the drill steel beneath. The water supply was controlled by a conveniently placed globe valve and the waste from the 2-in. pipe was carried away in a convenient drain.

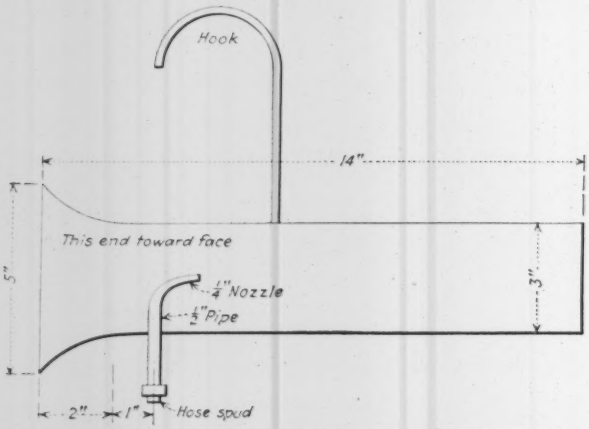


SKETCH SHOWING ARRANGEMENT OF WATER-COOLED SHIELD

Blower Clears Away Explosive Fumes

A SIMPLE and effective blower for expelling blasting fumes from any dead-end space has been devised by Edward H. Murphy, superintendent of the Harold mine of the Mark A. Hanna Company, near Hibbing, Minn. As shown by the drawing, which is reproduced from *The Explosives Engineer*, this consists of a horn-shaped collector combined with a small air-hose nozzle. The device is provided with a hook so that it can be suspended from any convenient projection.

When the air pressure is turned on, a considerable suction is produced at the wide end of the collector, so that the fumes are gathered from the fan and started on a straight course toward the exit. The usual procedure of simply allowing air to escape from a hose or pipe not only is extremely wasteful of air but is inefficient as well, for much of the gas swirls around in eddies and remains in the compartment. It is stated that the "smoke sucker," as it is called, has cleared the end of a 150-ft. drift, after a nine-hole shot of 45 cartridges, in three minutes, as compared with 30 minutes required by the old system.



SMOKE SUCKER FOR CLEARING OUT EXPLOSIVE FUMES

From Job and Office

Hints That Cut Cost and Time

Spacing Baffle Dams in Old and New Highway Side Ditches

By Mark S. Swain

Assistant County Engineer, Guadalupe County, Seguin, Tex.

EROSION of side ditches is one of the most troublesome problems of the highway engineer, especially in arid or semi-arid country subject to occasional heavy rains. The most common method of repairing and preventing eroded side ditches is by the use of baffle or check dams.

Concrete is generally used in constructing these dams, but the writer has also found grouted riprap a very satisfactory material, especially for maintenance work on old ditches. For best results and utmost economy, the accompanying formulas are given for the spacing of the baffles for both old and new highways. Fig. 1 is to be used for old, badly eroded ditches, and Fig. 2 for new installations.

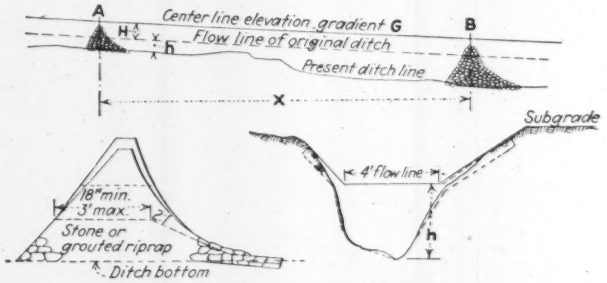


FIG. 1—CONSTRUCTION AND SPACING OF BAFFLE DAMS IN OLD ERODED SIDE DITCHES

Assume dam "A" built required to get distance to next dam "B" below "A"
Formula for spacing, $X = 100h \div (-G - 1)$
X = required distance A to B
h = height flow line at A above ditch bottom
G = gradient of road center line (in percentage)
H = height of road center line above flow line (usually 2½ ft.)

Proper spacing is desirable to keep the ditches from washing between baffles and yet to keep them apart far enough for economy's sake.

The formulas provide for a gradient of 1 per cent from the bottom of one baffle to the flow line of the dam immediately below. To use the formulas properly the spacing must proceed in the direction of flow.

From Job and Office

For Contractor and Engineer

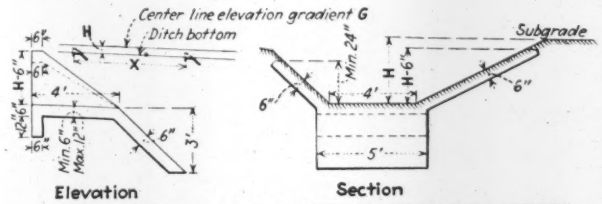


FIG. 2—BAFFLE DAMS ON NEW HIGHWAY PROJECTS
H = arbitrary height between flow line and road center line
Formula for spacing, $X = 200 \div -g$
X = required distance between dams
G = gradient of road center line (in percentage)

As an example of the spacing of check dams for eroded ditches as shown in Fig. 1, suppose that at the point *A* our first check dam is built with the bottom of the ditch 6 ft. lower than the center line of the finished roadbed. If we build our check dams to within 2½ ft. of the finished center-line elevation, the first check dam *A* will be 3½ ft. from bottom to flow line. If the gradient of the road is —5 per cent, by substituting in the formula we find that X equals $100 \times 3\frac{1}{2} \div - (-5) - 1$, which equals $350 \div 4$, or 87½ ft., the distance from the dam *A* to the next check dam *B* immediately below.

As an example of the use of the formula shown in Fig. 2 for the spacing of check dams in newly constructed ditches, assume the road gradient —5 per cent, the ditch gradient being the same, we have X equals $200 \div 5$ equals 40 ft., the proper spacing for these check dams on this gradient.

From an analysis of the examples given, it is evident that for this particular case two check dams of the type shown in Fig. 2 are needed as compared with one of the type shown in Fig. 1, but a careful estimate of the cost of the two types will give ample proof of the economy of building the smaller during highway construction, even though the additional maintenance expense of shouldering is not considered.

Jacking Culvert Through Railway Fill Aided by Top Shield

By N. H. Tunnicliff

Engineer, Levee Improvement Commission, Davenport, Iowa

A TOP SHIELD and trial of a novel (though unsuccessful) method of reinforcing an anchorage for a pushing jack were interesting points in the driving of a pipe culvert through a fill of the Davenport, Rock Island & North Western Railway by the Davenport Levee Commission, of Davenport, Iowa. The purpose was to drain a slough where stormwater from the city drains was impounded by the railway fill, which was built on a 6-ft. bed of mud or silt.

The culvert is of 5-ft. corrugated pipe, in 10-ft. lengths, coated with a bituminous paving composition, about ⅛ in. thick on both the outside and inside, while at the bottom this material was filled to a level surface about 1 ft. wide. The rear end of the longitudinal joint on each section was not shop riveted. After the next section had been entered for one corrugation, drift pins were used to match the rivet holes in the circular joint, working from the invert up both sides to the top. In every case the longitudinal joint came together satisfactorily. For the bottom holes, where rivets could not be used, the holes were enlarged with drift pins for $1\frac{7}{8}$-in. bolts.

Work was started on the south or river side, a trench 10 ft. wide and 15 ft. long being dug and crossties placed to carry two 4x6-in. timbers, 14 ft. long and 2½ ft. apart, forming a cradle for the pipe at the desired grade and alignment. A timber backstop was built against the outer end of the trench. Across the cradle timbers was laid a 10x12-in. jacking timber, 5 ft. long, and this bearing against the lower part of the pipe was found to be ample in forcing the pipe forward. No cutting edge was used. A 75-ton jack was used, being available, but a lighter jack could have done the work equally well.

One man in the pipe dug out the earth with a short-handled adz; another man shoveled it to the rear, where a third man cast it outside. The excavation was kept close to the outside diameter of the pipe, to prevent sliding or caving of the earth. It was made for about 2 ft. ahead, the pipe being jacked in 2-ft. moves. As the resistance became too great for the soft soil behind the backstop, a 20-ft. length of 2½-in. pipe was driven by hand through the fill for two ¾-in. steel cables, which were attached to the backstop and to a deadman on the north side, but unfortunately the direction of pull was such that the entire backstop was raised. After jacking three lengths of pipe the backstop failed.

PIPE CULVERT WITH TOP SHIELD

Work was then started in the same way on the opposite side of the fill, where the material was firmer, the cradle timbers being placed to a grade and line checked with the pipe already installed. Two 10-ton track jacks gave sufficient power for the two 10-ft. lengths of pipe that were driven. A shield consisting of a sheet of corrugated iron 4x8 ft. was bolted temporarily on top of the front end of the first pipe, as shown in the accompanying view, the corrugations being lengthwise of the culvert. When the pipe and shield had advanced until angle-iron lugs (which can be seen in the accompanying illustration) on the rear of the shield pressed against the earth, the bolts were removed and the shield remained stationary.

This device reduced the top pressure and friction, so that two men on a 10-ton jack could move the pipe. The pipes met exactly and one section was entered into the other for one corrugation, but it was not considered necessary to rivet this middle joint. A 10-ft. length of pipe, with hinged flap gate to prevent backwater inflow, was added to the lower end of the culvert, and two 10-ft. lengths to the upper end, making a length of 80 ft. The total cost was about $2,000 for material, with a labor cost of $7 per foot for jacking 50 ft. of pipe and $2 per foot for placing and riveting the pipe in open trench. This culvert work was designed and supervised by the writer.

Letters to the Editor

A Forum for Discussion of Views of Engineers and Contractors

River Control and Cutoffs

Sir—The article by W. E. Elam on "Flood Control Through Slope Correction," as related to the Mississippi River, is decidedly interesting. This subject has received the thought of most hydraulic engineers who have been connected with, or studied, the problems of the Mississippi River. It is not a new subject, but it is one to which a solution has not as yet been found.

The observations of the author are interesting but some of the statements and conclusions are not borne out by experience and facts. Thus, the statement that "uniformity of flow is desirable and essential to adequate river control," is true insofar as low-water flow and navigation are concerned, but not for flood flow. It may be desirable for flood flow, but is not essential, and where it can not readily be obtained heavy expense is not justified.

The author takes the position that the revetment of bends where caving takes place is necessary in order to force vertical, rather than horizontal, cutting. There is no proof in the article, neither is it an accepted principle, that the prevention of horizontal erosion will force deepening of the channel. As a matter of fact, it is generally conceded that the best method of deepening the channel would be by shortening it, together with the prevention of horizontal erosion to maintain the shortened length. The bed of the Mississippi River is of a very unstable nature, and if the velocity is increased by shortening the channel and the shortened length maintained by some type of control works the channel would undoubtedly deepen.

Another statement is made that levees should be so constructed that the high-water channel will have the same length and location as the low-water channel. In support of this theory it is stated that the channel is in much better condition from Baton Rouge south, where the levees are located closely along the banks of the river. This may be true, insofar as the low-water profile is concerned, but the discussion is presumably from the standpoint of flood control. A uniform slope line is not necessary for flood flow, although it may be desirable for low-water flow from the standpoint of navigation. Furthermore, the construction of levees close along the river channel would increase the stage for floods that have any reasonable depth of overbank flow.

It is stated that backwater levees up the main tributaries to reduce the backwater areas would be an advantage. This may be true in some places and not in others. In some of the areas where investigation has been made it has been found that the drainage area tributary to the leveed backwater area would produce enough run-off to fill the backwater area about as fast as the river rises. Where that is the case, it would have no effect whatever on the river whether backwater levees were built and the area filled in by local rain water, or whether the area were left open for the storage of river water. However, in localities where the local drainage area did not produce enough run-off to utilize the storage capacity, the exclusion of the river flood water would cause the stage in the river to increase more rapidly than though the water were allowed to back in and occupy the reservoired area as the river rises. Where such is the case, the river would reach a higher stage, unless the water be later on allowed to flow into the leveed backwater area before the crest were reached. Should this be done, it is problematical whether it would be better to allow the water to flow gradually into the reservoired area as the river rises, or let it reach a stage approaching a maximum before arresting its rise by letting it flow into the reservoired area.

A further statement is made that possibly a reasonable number of cut-offs should be made to straighten the channel and produce bottom cutting to lower and enlarge the channel and equalize the slopes. This statement appears to the writer to be the most important of all in connection with securing flood control through slope correction. If the channel can be shortened and the shortened length maintained, the river will undoubtedly deepen its channel and the elevation of the flood plane be lowered.

So far, no adequate method of controlling the length of the channel has been evolved, except at prohibitive cost. So far as the writer knows, no intensive study of this method of control has ever been made. As a matter of fact, the last intensive study of the river, as well as the first, was made by Humphrey and Abbot over fifty years ago.

An intensive study should now be made of all phases of the river problem. Most large industrial or scientific organizations maintain a group of specialists who work continually on the development of special problems. A similar group should be employed and assigned to the study of all the hydraulic problems of the Mississippi River.

The problem of deepening the channel by shortening the course of the river could well be studied, first in a hydraulic laboratory; then the more favorable methods that develop be tried out on the river itself, on actual conditions as they exist in the field. It is not at all unlikely that some method of control could be determined that would shorten the channel and maintain it in its shortened condition and cause it to deepen itself enough to lower the flood plane measurably. Such regulation would make the low water channel more uniform and be an aid to navigation.

Memphis, July 3. L. L. HIDINGER.
President, Morgan Engineering Company.

Treating the Heads of Wood Piles

Sir—In the construction of docks around the Great Lakes it is expensive to require the contractor to place all of the timber work below the lowest stage of water. Further, when piles are used for foundation work, the elevation of the level of the groundwater may not be known precisely, and so it becomes necessary to carry the concrete foundations down or lengthen out the piles with concrete. Is there not some way of treating a few feet of the top of the piles so that it will not be necessary to increase the cost of the work by sawing them off at a low elevation? This subject is of importance to many engineers and contractors in connection with dock and foundation work.

FOUNDATION ENGINEER.

[Brush treatment with preservatives might not give sufficient protection or durability, but electric companies make extensive use of the dipping or open-tank treatment for the lower ends of their poles and a similar process might be applied to the heads of piles.—EDITOR.]

Changes in Plans for Pacoima Dam

The Pacoima dam, now being built by the Los Angeles County Flood-Control District, will be kept down to an effective height 10 ft. lower than had been planned. The changes have been decided upon, according to E. C. Eaton, chief engineer of the district, in accordance with the recommendations of the consulting board of engineers, consisting of J. B. Lippincott, D. C. Henny and J. W. Reagan.

Under the original plans the dam was to be built to El. 2,025. The changes recommended are that the dam be finished to El. 2,015 and that a tunnel spillway be built having a size sufficient to take a flood-flow peak of 450 sec.-ft. per square mile without allowing the reservoir level to rise above El. 2,010. The capacity of the reservoir at El. 2,015 would have been about 13,000 acre-ft. and at El. 2,010 it will be 11,000 acre-ft. The design of the tunnel recommended is now in progress. It will be about 15 ft. in diameter. An existing tunnel at El. 1,975 is 6 ft. in diameter. The combined capacity of the two tunnels will be 7,000 sec.-ft.

News of the Week

Current Events in the Civil Engineering and Contracting Fields

Commission Named For Investigation of Boulder Dam Project

Five Engineers and Geologists Named to Study Project—Early Report Expected

APPOINTMENT of the commission of engineers and geologists to report on Boulder Dam, according to a resolution of Congress, was announced by the Secretary of the Interior July 7. The following were named: William L. Sibert, major-general, U. S. Army, retired; D. W. Mead, professor of hydraulic engineering, University of Wisconsin; Robert Ridgway, chief engineer of the Board of Transportation of New York City, and former president of the American Society of Civil Engineers; Charles P. Berkey, professor of geology, Columbia University; and W. J. Mead, geologist, University of Wisconsin.

This commission, under a joint resolution adopted at the last session of Congress, is to examine the proposed site of the dam, review the plans and estimates made therefor, and to report on "matters affecting the safety, the economic and engineering feasibility, and the adequacy of the proposed structure and incidental work."

In announcing the appointments Secretary Work stated that the selections had been made because of the eminence of each man in his profession, and for the reason that he has not been connected with the area to be studied either through personal interest, residence or previous intimate knowledge of the project.

General Sibert, after a long career in river and harbor work, built the great Gatun Locks and dam at Panama and the breakwater at Colon harbor. He was Red Cross chief engineer for the study of flood prevention in China. He commanded a division in France during the World War and returned to America to organize the Chemical Warfare Service. He retired from active service in 1920.

Robert Ridgway was division engineer on the construction of the Catskill aqueduct and then entered the subway construction service of New York City. He has been chief engineer of the Board of Transportation for a number of years. A year ago he served as member of the board of three to decide on a location for the San Francisco Bay bridge.

Daniel W. Mead, long prominent in hydraulics, was at one time city engineer of Rockford, Ill., but has been professor of hydraulic engineering at the University of Wisconsin for 25 years. He was a member of the Chinese flood-prevention commission.

Warren J. Mead, geologist, has been a member of the faculty of the University of Wisconsin since 1906. He has long had a consulting practice in economic and engineering geology.

Charles P. Berkey, professor of geology at Columbia University since 1903, was geologist for the Board of Water Supply of New York City on the Catskill aqueduct, and geologist of the Third Asiatic expedition of the American Museum of National History. He has had many years of service as consultant in the application of geology to engineering undertakings.

Changes Proposed in Engineering Standards Committee

The main committee of the American Engineering Standards Committee has unanimously approved a plan for the reorganization and enlargement of that body, and a change of name to the American Standards Association. The plan is now being voted upon by the various member bodies of the Association. The new plan is the result of the growth of the industrial standardization movement in the United States, and the desire to expand the Standards Committee to keep pace with this growth. The American Standards Association will be a definite federation of national organizations, organized in such a way that trade associations interested in standardization may readily join the movement. The technical work of approving new standards will rest in a Standards Council, while the administrative and financial responsibility will be concentrated in a Board of Directors composed of twelve industrial executives.

Southern Pacific to Construct New Connecting Line

The Southern Pacific Railway has completed surveys, and will start construction immediately, of 97 miles of new line connecting Klamath Falls, Ore., and Alturas, Calif. This will give Oregon and northern California a new east and west line, which will connect the Southern Pacific's Shasta route with its Nevada-California-Oregon line. The new line has been approved by the Interstate Commerce Commission.

The territory to be served includes a large amount of high grade agricultural land, as well as one of the largest stands of virgin pine timber in the United States.

American Engineers War Memorial in Belgium Dedicated

Clock and Carillon for Library at Louvain Given in Memory of Engineers Killed in War

THE first memorial to the engineers in the United States forces who lost their lives in the great war was dedicated July 4, in connection with the dedication of the new Louvain Library. The memorial consists of one of the finest carillons yet made, a great tower clock, and a volume containing the honor roll of the names of the dead, and other records, and a perpetual maintenance fund of $10,000. The committee on war memorials to American Engineers also presented to the University of Louvain a silk flag representing the engineering societies, the flag of the Society of American Military Engineers, and a standard United States of America silk regimental flag. These three flags will be placed permanently in the library reading room, in company with many other universities and organizations.

The carillon contains 48 bells tuned to the chromatic scale, and has a compass of a little more than four octaves. A replica of the great bell of the carillon which is ornamented with emblems of the engineering societies is to be hung in the great reading room of the library.

The clock has four dials each 16 ft. in diameter, with gilt-bronze stars instead of numerals. At the quarter hours the clock will automatically play chimes in selected bells of the carillon. The hours will be struck on the great bell which weighs 15,600 lb.

The committee which had charge of the war memorial is as follows:

Edward Dean Adams, Arthur W. Berresford, Arthur S. Dwight, Alfred D. Flinn, L. R. Lohr.

The various engineering societies appointed the following men to represent them at the dedication ceremony:

American Society of Civil Engineers: George S. Davison, William J. Barney, William K. Hatt.

American Institute of Mining and Metallurgical Engineers: Ronald Clark, Millard K. Shaler, Firmin Van Bree.

American Society of Mechanical Engineers: Laurence V. Benet, Henry S. Downe, Clarke Freeman.

American Institute of Electrical Engineers: John W. Lieb, William H. Onken, Jr., Michael I. Pupin.

American Institute of Consulting Engineers: E. P. Goodrich.

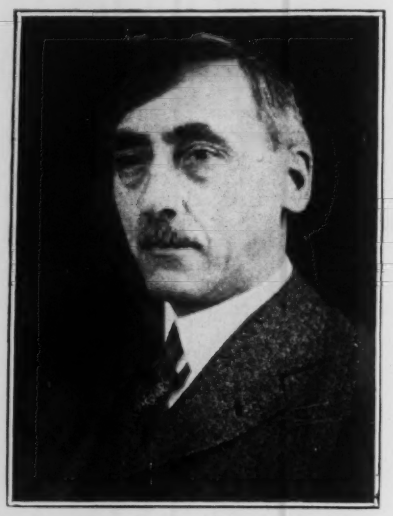
(Continued on p. 75)

F. E. Schmitt, New Editor, Long With Engineering News

Began His Journalistic Career in 1902—Succeeds the Late Frank C. Wight

Frederick E. Schmitt, whose appointment as editor of *Engineering News-Record* was announced last week, comes to the work well equipped, having been active in technical journalism for more than a quarter century. During this time he has seen service in all branches of the editorial work.

Born in New Jersey 48 years ago, Mr. Schmitt received his technical education at the University of Wisconsin.



Frederick E. Schmitt

After some years of practice in machine construction and structural steel design, the latter with the old Berlin Iron Bridge Co. and its successor the American Bridge Co., he joined the staff of *Engineering News* in 1902, and after an apprenticeship of several years was promoted to associate editor. In this position he continued until the sudden death of Frank C. Wight, editor, last September, when he took temporary charge of conducting the paper as managing editor.

During his early years on *Engineering News* he was given the assignment of "covering" the collapse of the Quebec Bridge, in August, 1907, and in this work accomplished a journalistic feat that won countrywide recognition in the engineering profession, by reporting the circumstances and causes of the collapse exhaustively and accurately in the first issue following the accident. The story was written in one continuous day and night session after his return from the scene of the failure. Out of this report developed a widespread agitation for the fuller study and improved design of large compression members, a movement in which he was an active figure.

His principal contributions to the paper throughout his service have been in the structural field, concerned with steel bridge and building work, foundation construction, dams, concrete and related subjects; but he also had to deal with many important special assignments, such as the failure of the Austin (Pa.) dam, the Knickerbocker Theater roof collapse, wartime emergency shipbuilding methods and plants, the Florida hurricane, and the crisis in reclamation five years ago.

In addition to his journalistic work, Mr. Schmitt has been active in engineering societies, principally the American Society for Testing Materials, the American Society of Civil Engineers and the American Association of Engineers. He has taken part in important committee work, serving on the organizing committee of the International Congress for Testing Materials in 1912, and as chairman of its papers committee; on the research committees of the American Society of Civil Engineer, and the American Society for Testing Materials; and on numerous technical committees, among others, committees on stresses in structural steel, on structural safety, on yield point of structural steel, and on wood utilization.

Special Board to Consider Submarine Salvage Ideas

Since the sinking of the submarine S-4 off Provincetown, Mass., on December, 17, 1927, the Navy Department has received over 6,800 communications describing more than 4,000 ideas, suggestions and plans for increased safety of submarine operation, particularly regarding rescue of members of the crews of sunken vessels. Many of the ideas have been carefully illustrated by plans and working models. Due to the desire of the Navy Department to give full consideration to each of the suggestions, a special board of five men has been appointed to consider the general subject of submarine safety devices, giving special attention to the devices submitted. The members of the board are: Joseph Strauss, rear admiral, U. S. Navy (retired); David W. Taylor, rear admiral, U. S. Navy (retired); W. R. Whitney, director of the research laboratory of the General Electric Company, and member of the Naval Consulting Board since 1915; and Thomas A. Scott, consulting specialist on salvage operations for the Merritt-Chapman & Scott Corporation. John F. Stevens, past-president, Am. Soc.C.E., was also appointed a member of the board, but he will be unable to serve at this time. His successor will be appointed in the near future.

The board is empowered to call any witnesses desired, whether they be officers of the navy or civilians. It will have at its disposal the hulk of the S-4, now at Portsmouth, N. H., for use in testing out any devices which may be deemed worthy of practical demonstration. A sum of $200,000 has been made available for the tests by a recent act of Congress.

Licenses for Contractors Required In Portland, Ore.

Beginning July 1, all building contractors in Portland, Ore., are required to have licenses from the city authorizing them to engage in the contracting business. Building permits will be issued only to licensed contractors and to building owners who intend to do their own work. After the expiration of a 30 day period during which present contractors will be allowed to obtain licenses without examination, no license will be granted until after examination by a board of five men appointed by the mayor. The board is to consist of a registered architect, a registered structural engineer, two building contractors of five years experience in the city, and a building owner.

Three general classifications are provided, depending upon the responsibility and difficulty of the work.

Bids Opened for Kill van Kull Bridge Abutments

The Port of New York Authority on July 5 opened the first bids for construction of the new arch bridge over the Kill van Kull between Bayonne, N. J., and Port Richmond, Staten Island. The work covered by the bids includes the two main abutments complete, ready for the masonry superstructure and steel. The foundations of the main abutments will be built by the cofferdam method. Data obtained indicate a water depth on the Port Richmond abutment of 5 to 8 ft., and a cover over the rock varying from 10 to 16 ft. Similar figures on the Bayonne abutment indicate water depth from 8 to 10 ft. and rock cover varying from 0 to 5 ft. Each abutment will consist of an irregular-shaped granite-faced block of concrete covering an area approximately 110 by 134 ft. Each abutment will be constructed in two units, keyed together by a concrete key 4 to 6 ft. in width. Structural steel anchor frames for supporting the main arch shoes will be embedded in the abutment.

The complete bridge will cost about $16,000,000, and will be completed in 3½ years. It will consist of an arch span of approximately 1,600 ft.

The amounts of the bids are as follows:

H. P. Converse, Boston, Mass., $515,709; Cornell Contracting Corporation, $544,300; G. De Kimpe, Ridgefield, N. J., $567,000; Triest Contracting Company, $574,200; Tunnel Construction Company, $578,900; Silas Mason Company, $588,700; Merritt-Chapman & Scott Corporation, $594,000; Frederick Snare Corporation, $628,100; Arthur McMullen Company, $652,500; Foundation Company, $659,000; Necaro Company, $660,900; W. H. Gahagan, Inc., $677,100; Albert A. Volk Company, $733,000; Stillman-Delehanty-Ferris Company, of Jersey City, $739,930; Phoenix Construction Company, $777,900.

Bidders are from New York City unless otherwise noted.

Canadian Governments to Build Conservation Dam

Action of the government of Ontario on June 28 provided definitely for the construction of a conservation dam near Kenora, Ontario, with a view to benefitting and increasing power holdings on the English and Winnipeg Rivers. The dam will be near the Lower Ear Falls at the western end of Lac Suel. The cost of the undertaking will be shared by the governments of Manitoba, Ontario and the Dominion of Canada.

New Ruling on Cross-Connections in New York State

Postponement for not over six months from July 1 of the date for the abolition of all cross-connections between potable public water supplies and auxiliary industrial or fire supplies in New York State is provided for by a resolution of the Public Health Council, adopted June 29. The resolution mentions "a new development in chlorinating apparatus . . . which possibly may permit certain plants to treat their auxiliary water supplies, thereby rendering them potable from a public health standpoint."

In a follow-up announcement dated July 3, issued by M. Nicoll, Jr., State Commissioner of Health, the new chlorinating apparatus is briefly described, and the conditions under which it may be employed, subject to approval in all cases by both the local water authorities and the State Department of Health, are given. The apparatus is described as a "special fire pump chlorinator," shown by tests to be "capable of effectively chlorinating an auxiliary supply under intermittent operation of fire pumps," provided such supply is "not too grossly polluted." The chlorinator operates continuously, constantly wasting a small amount of chlorine solution, but on starting the fire pump it automatically and immediately supplies "a predetermined amount of chlorine to the suction of the pump," thus "overcoming the limitations of intermittent chlorination."

Under the terms of the circular of July 3, "those in charge of public water supplies" may apparently choose between ordering all cross-connections entirely eliminated, or permitting chlorination by the means indicated above as a substitute.

Rules for installation of the new type of apparatus have been formulated and are embodied in the circular of July 3, which doubtless may be obtained by addressing the New York State Health Department, Albany, N. Y. Among the stipulations are: The auxiliary water supply "must not be so grossly polluted that it cannot be effectively chlorinated." The fire supply must be drawn either "from an open well or pump or there must be a municipal water supply available having a pressure at least three times as great as the pressure on the suction of the pump." The chlorinator ejector must be supplied from the municipal water supply. The auxiliary chlorinator must be able to "apply chlorine at the rate of not less than 20 lb. per m.g. of water pumped" immediately the fire pump is started. Daily orthotolidine tests of the chlorine solution wasted must be made and the results of these, together with the amount of chlorine wasted or used per day must be submitted at least monthly to the municipal water supply authorities. Notwithstanding the use of the special chlorinator, the rules provide that "double check valves of the 'all bronze' type must be placed on any cross-connection between a potable municipal supply and a chlorinated industrial or fire supply."

Cobble Mountain Dam and Tunnel Bids Are Opened

Bids were opened Monday, July 9, on the proposed Cobble Mountain dam and tunnel for the Springfield, Mass., water supply system. Low bidders on the dam, which is to be one of the highest earth dams in existence, were: Winston & Company, Harrisburg, Pa.; Carlton & Company, New York City; and Rinehart & Dennis Company, Charlottesville, Va. On the 7,000-ft. outlet tunnel, low bidders were: Frazier-Davis Construction Company, St. Louis; R. S. Morrow & Son, Omaha, Neb.; and Rinehart & Dennis Company, Charlottesville, Va. The contract on the dam includes, besides the dam itself, clearing nearly 1,100 acres, building the spillway and a highway bridge, also closing the present diversion tunnel. Contracts have not yet been awarded.

Canada to Build Lake Terminal on St. Lawrence

The Canadian government has announced that, subject to an arrangement with the United States as to work to be done in the channel of the St. Lawrence River, the Great Lakes Terminal for deep-water shipping will be established near the town of Prescott, Ont. Prescott is nearly opposite Ogdensburg, N. Y. The new terminal is made necessary by the deepening of the Welland Canal, which will enable Great Lakes vessels to transfer their cargoes to the railroad at Prescott. The work of construction, which will cost about $4,000,000, will be started next fall.

Louvain Memorial Dedicated

(Continued from p. 73)

American Institute of Chemical Engineers: Charles L. Reese.

Society of Naval Architects and Marine Engineers: J. O. Gawne.

Society of Automotive Engineers: Arthur Jarvis Slade.

Society of American Military Engineers: Capt. L. R. Lohr.

American Railway Engineering Association: William K. Hatt.

Rock Island Railroad Starts Flood Protection Work

The extremely heavy rains and floods in the Middle West during the past two years have prompted the Rock Island Railroad to embark upon a systematic plan of flood protection along its lines in nine of the fourteen states through which it passes. Improvements will be made with a view to avoiding future damage to the railroad property and possible interruptions to traffic. It is planned to expend $642,000 during the coming year. While this is only a part of the total amount which will be required, it is expected to take care of the points where the greatest damage is liable to occur.

The largest single improvement in this year's program consists of the raising of several miles of track along the Mississippi River in Arkansas. This one project will cost approximately $146,000. Other work will be done in Illinois, Iowa, Missouri, Oklahoma and Texas.

New Reservoir and Conduit Planned for Rochester

Approval of the Honeoye Lake reservoir project by the New York State Water Power and Control Commission makes possible the immediate extension of the water supply of Rochester, N. Y. An aerial survey of the project is now under way, and it is stated that construction work will start in the near future. The project includes an earth dam 800 ft. long and 60 ft. high, together with two conduits, probably of 60 in. steel pipe, from the reservoir to the Cobbs Hill distribution reservoir in the city limits. The new project will provide an additional supply of 55 m.g.d. The estimated expenditure for the reservoir, dam, and one conduit to be constructed immediately, is $12,000,000. Plans for the project were prepared by Allen Hazen, Harrison P. Eddy, and Edwin A. Fisher, consulting engineers. A total area of land 15 miles long and 3 miles wide will be acquired by the city in order to provide a protective belt around the reservoir. This land will probably be reforested and possibly used for park purposes under suitable restrictions.

In granting the application of Rochester, the Water Power and Control Commission specified that a filter plant must be provided of sufficient capacity to filter all water used from the new reservoir at the time of completion. As it is believed possible that the quality of the water will improve in later years, the matter of additional filter capacity to take care of increased needs is deferred until such time as it may be necessary to take it under further consideration. It is also provided that certain other municipalities which have been dependent upon the outflow from the present Honeoye Lake shall be permitted to secure their water supply from the new system upon approval by the Commission.

World-Wide Municipal Congress to Meet in Spain

The fourth International Congress of Cities will be held in Seville, Spain, from March 19 to 23, 1929, in connection with the Spanish-American Exposition to be opened at that time. The congress will be sponsored by the International Federation of Local Government Associations (Union Internationale des Villes et Pouvoirs Locaux), of which the American Municipal Association and the International City Managers Association are active members. The meeting of the congress is included in the itinerary of the tour of American city officials to European cities which is being arranged by the American Municipal Association, with headquarters at Lawrence, Kan.

World Engineering Congress Outlines Program

The World Engineering Congress, which is to meet in Tokyo, Japan, in October, 1929, and to which a large number of eminent engineers and industrialists from the United States have been appointed delegates, has issued a pamphlet outlining the scope of its technical program. The papers to be presented under this program are of two kinds—namely, papers on assigned subjects and papers on subjects chosen by the authors. In either case the papers will be examined by a committee on papers in order to judge of their agreement with the object of the congress. This object, as stated by the World Engineering Congress, is (1) to advance and diffuse knowledge, by reading papers and carrying out discussions, on scientific subjects relating to engineering at large, and to interchange views on various phases of professional work; and (2) to record papers, discussions, etc., with decisions thereupon, so as to contribute a valuable addition to engineering literature.

The parts of the technical program of interest to the civil engineering profession are as follows: (1) General problems concerning engineering, such as education, administration, standardization, international co-operation of engineers, etc.; (2) engineering science, such as strength of materials, thermodynamics, hydraulics, etc.; (3) precision machines and instruments; (4) architecture and structural engineering, including the housing problem, bridge engineering, fire protection, earthquake-proof construction, framed structures, masonry construction, reinforced-concrete construction, etc.; (5) public works, including river and harbor engineering, water-works, sewerage, city planning, etc.; (6) railway engineering; and (7) transportation, including land, water and aerial methods.

Old Buildings Burned in Fire Test

The intensity and duration of fires in buildings and the fire-resistive qualities of safes and other record containers were measured recently by the Bureau of Standards when it burned to the ground two old business structures in Washington. Waste lumber and other combustibles were placed within the structures to simulate conditions which would have prevailed had the usual office equipment been present. Thirty-five different makes of safes and containers filled with useless records were placed at different points in the buildings. Each safe and container was equipped with thermometers and other recording devices so arranged as to record the highest temperature reached within each and the moment of impact as they fell through the burned-out floors into the débris below. Thermocouples with leads extending to a protected place near the burning structures permitted the recording of temperatures at 50 points in the open places within the buildings, while the temperature was being measured at 45 points in the débris. The results will be transcribed from the recording instruments, and when complete data have been assembled and interpreted, the results of the test will be made available.

Flood-Control Survey Started on Passaic River

A flood-control study of the Passaic River, in New Jersey, from tidewater to the town of Little Falls has been started by C. C. Vermeule and G. W. Knight, appointed by the New Jersey State Board of Conservation and Development. A report is to be made to the legislature of New Jersey by Dec. 15. Investigation will be made along the upper reaches of the river for potential flood-control reservoirs.

Washington Notes

By Paul Wooton
Washington Correspondent

Large Ammunition Depot Planned—A.G.C. Urges Sound Credits—Power License Surrendered

PREPARATION of plans for the construction of the large ammunition depot at Hawthorn, Nev., has been begun by the civil engineers of the Bureau of Yards and Docks of the Navy Department. This project involves an expenditure of $3,500,000. Requests for bids probably will be sent out within five months. It is expected to start construction early next year. The engineers of the Bureau of Yards and Docks point out that the construction of this depot is unusual because of the many subsidiary units making up the project. The industrial unit includes a central heating plant, oil storage tanks and shop buildings. The magazine unit is comprised of cooling houses and detonation structures. The service unit, in addition to the power house and pumping plant, will contain a sewage disposal plant.

Would Stabilize Contracting

IN addition to its efforts to secure the enactment of a uniform mechanics lien law in the various states,

LEE'S FERRY BRIDGE, ARIZONA, AND THE DANGEROUS ROAD IT WILL ELIMINATE

Lee's Ferry bridge will connect the highway systems of Arizona and Utah, replacing a historic ferry and a narrow, crooked road down the walls of Marble Canyon. The pictures show a portion of this road, and erection work on the south half of the bridge. The total span of 608 ft. will be 467 ft. above the surface of the Colorado River.

the Associated General Contractors is endeavoring to aid in the stabilization of contracting by urging the establishment of a sound credit structure. It is suggested that the building supply trades agree to liberal discounts on bills paid prior to the tenth day of the following month, and to penalties on bills not paid within thirty days. Arrangements have been completed for a trial of this plan in Detroit and are underway at Louisville, Memphis, Denver, St. Louis and Minneapolis. In each city the plan will be administered by a local allied industries committee. In addition to the elimination of the irresponsible contractor, it is believed that such a plan will have an important bearing on checking unsound tendencies in the business.

Advisory Board Meets

FOR the purpose of recommending policies to be pursued under the Denison act, the Advisory Board of the Inland Waterways Corporation was scheduled to have met in Washington July 11. The Denison act authorizes an appropriation of $10,000,000 for the continuation of the experiment in transportation which the government has been conducting on the Mississippi and Warrior Rivers. As the amount is insufficient to provide for any important extension of the service, it was thought before the meeting that the board would recommend that most of the money be used for the purchase of additional equipment. At times the corporation is not able to move all of the tonnage offered. There is also need for more power boats. Studies made by the corporation's staff indicate that Diesel-driven equipment may be expected to give best results under conditions prevailing on the lower Mississippi. The advisory board as constituted at present, is as follows: James E. Smith, St. Louis; S. S. Thrope, Minneapolis; M. J. Sanders, New Orleans; Wilmer M. Jacoby, Pittsburgh; H. E. Halliday, Cairo; and R. A. Brown, Birmingham.

Niagara Water Rights Returned

SURRENDER of its license by the Lockport and Newfane Mill Owners' Association has been accepted by the Federal Power Commission. This license covered the diversion of treaty water used on 18-Mile Creek, New York. The water now is available for more efficient use in the plants of the Niagara Falls Power Company.

Under the new ruling of the commission, however, the application of the Niagara Falls Power Company for an amendment to its license will not be laid before the commission until complete agreement as to the costs involved will have been reached with the staff of the commission. In the meantime the Niagara company may not utilize the water.

It is contended in the industry that the effect of the order is to require the applicant to accept the views of the commission's staff regarding pre-license costs, or be denied the rights extended by the water power act.

Engineering Societies

Calendar

Annual Meetings

AMERICAN SOCIETY OF CIVIL ENGINEERS; Annual Convention, Buffalo, N. Y., July 18-20.

NEW ENGLAND WATER WORKS ASSOCIATION, Boston, Mass.; Annual Convention, Montreal, Canada, Sept. 18-21.

AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS, St. Louis, Mo.; Annual Convention, Detroit, Mich., Oct. 22-28.

THE ST. LOUIS SECTION, Am.Soc.C.E., held a meeting on June 25 at which J. H. Porter, engineer, a member of the Missouri Public Service Commission, discussed the importance of valuations of public utilities in the regulation of such organizations, and the part played by the engineer in this work.

Brief News

THE CAISSON OF THE MID-HUDSON BRIDGE at Poughkeepsie, N. Y., is being slowly righted. Originally listing to an angle of 43½ deg. from the vertical, it has now been pulled back about 30 ft., approximately half the required distance. It is being righted by dredging under the high side, at the same time pulling with heavy tackle on the upper edge. A previous note on the work appeared in *Engineering News-Record*, June 14, 1928, p. 947.

THE COLLAPSE OF A MUNICIPAL DAM near Cookeville, Tenn., and the cutting off of the natural gas supply of Louisville, Ky., by a land slide, are results of recent heavy rains in the South. The damage to roads, brides, buildings, transmission lines and crops will amount to many thousands of dollars. Water was reported 4 ft. deep in some of the streets of Louisville, and many trolley lines suspended operation.

COMPLETION of the natural gas pipe line from north Texas to Denver was signalized on June 21, when gas was turned into the main to take out the air. It will take five weeks to change and adjust the population's manufactured gas appliances, after which all of the city will be using the natural gas.

A PLAN FOR HARBOR IMPROVEMENTS at St. John's, N. B., involves an expenditure of $5,000,000 in a period of three years. The plan calls for a new grain elevator, a series of docks, sheds, and other port equipment.

AN AERIAL SURVEY of the city of Montreal has recently been authorized for use in advancing city planning, zoning, the study of transportation, and traffic control.

Personal Notes

BLAKE R. VANLEER, assistant professor of mechanical engineering at the University of California, has been appointed Assistant Secretary of American Engineering Council. Mr. Van Leer has degrees from Purdue and California Universities. He served with the 316th Engineers in France and was one of the first of those selected to go to Europe under the Freeman hydraulic laboratory scholarship.

ROY W. SHAVER, of Oswego, N. Y., has accepted a position with the Oswego Falls Corporation at Fulton, N. Y. He will supervise construction on an expansion program of that corporation, which includes a large new factory building for which the Austin Company, of Cleveland, Ohio, have the contract.

S. B. MOORE is now chief engineer of the Nicaraguan Division of the Standard Fruit & Steamship Company, with headquarters at Puerto Cabezas, Nicaragua.

L. M. FISHER, sanitary engineer with the U. S. Public Health Service, has been transferred from Providence, R. I. to New York City to take charge of the Interstate Sanitary District No. 1.

GEORGE W. SWENSON, assistant professor of electrical engineering at the University of Minnesota, has been appointed head of the new department of electrical engineering at the Michigan State College of Mining and Technology, Houghton, Mich.

Obituary

GEORGE STRONG BAXTER, railway contractor and lumber operator, died July 2 in New York City at the age of 82. Among the construction jobs with which he was connected were the elevated structure of the New York Central north of 96th Street and the foundations for the Second and Third Avenue elevated lines in New York City. He worked for many years with the Northern Pacific Railroad, and was for a time, treasurer of that organization.

JOSEPH B. BARRETT, of Rochester, N. Y., for 43 years a civil engineer in the State Department of Canals and Highways died in that city on July 7, aged 60 years. Mr. Barrett was born in Lockport, N. Y. At one time he was in charge of Contract No. 6 of the Barge Canal. Recently had been in charge of highway construction work near Rochester.

ABNER T. YOUNG, civil engineer, vice-president and general manager of the San Luis Central Railroad Company, died at Denver, Colo., on June 28, aged 56. Mr. Young built the San Luis Central and had also been connected with the Union Pacific and other railroads.

Construction Equipment and Materials

A Section Devoted to What the Manufacturer Is Doing for the Engineer and Contractor

Penn-Dixie and North American Cement Merger Fails

Consolidation of the North American Cement Company and the Pennsylvania-Dixie Cement Corporation, was not approved by the stockholders and Frederick W. Kelly, president, North American Company, states that no further steps will be taken to bring the concerns together under the name of the General Cement Corporation. "The whole proposition must be looked upon now as an experience," Mr. Kelley said. "We as the directors and servants of the stockholders did what we could to bring the matter about and we had the support of an overwhelming majority of the stock. It had been agreed that a certain percentage of the debenture holders in North American must deposit their holdings with an agreement to accept in exchange preferred stock in the new corporation. When we found the bonds had not been deposited in sufficient number to meet that provision, we abandoned the plan."

How Are Plans to Prospective Bidders Mailed?

A manufacturer of equipment in the civil engineering-construction field recently remarked that one of the best improvements that could be made in relations between the manufacturer and the user of equipment built to specification would be for the organization letting the contracts to mail the plans parcel post C.O.D. This manufacturer stated that it was next to impossible to get a bid in on time under some present conditions. Not only is it necessary for the manufacturer to write for specifications, but the engineer will write back asking for a check before he can send the plans. By the time the check reaches him and the plans are sent to the manufacturer, the time is too short to figure the job and get the bid in on time. Questions arise as to whether other manufacturers building equipment to specification are experiencing the same trouble and whether they agree that the mailing of plans by parcel post C.O.D. is a remedy. We will welcome a discussion of the subject.

B. S. Smith, Becomes President of Pennsylvania-Dixie Cement

Blaine S. Smith has resigned as vice-president of the Universal Portland Cement Company to become president of the Pennsylvania-Dixie Cement Corporation, succeeding John A. Miller, who becomes chairman of the board. Mr. Smith started work in the traffic department of the Chicago & Northwestern Railroad in Chicago and in 1908 went to the Universal company. Within seven years he was made general manager, and later vice-president.

Mr. Smith has served on various committees of the Portland Cement Association, for three years was chairman of the committee on advertising and publicity, for two years was vice-president, and in 1924 was elected and the following year re-elected president of that organization. He is a member of the A.S.T.M., A.C.I., Western Society of Engineers and the American Iron and Steel Institute.

Business Notes

Asphalt Paving Processes, Inc., with headquarters at Raleigh, N. C., has been organized as a co-operative organization by several paving construction companies. The officers of the new organization are Frank B. Thompson, president, Augusta, Ga.; F. J. Blythe, vice-president, Charlotte, N. C., and George B. McGrath, general manager, Raleigh, N. C. Representatives of the paving companies interested declare the purpose of the new organization is to present to engineers and governing officials the most improved construction methods available.

Chicago Pneumatic Tool Company, New York City, announces the appointment of George J. Lynch as district manager of sales of St. Louis. Mr. Lynch was formerly assistant district manager in the New York office.

G. H. Williams Company, Erie, Pa., announces that Carl F. Weiblen, formerly manager at Cleveland and previous to that a member of the home office organization at Erie, has been appointed Chicago manager. Mr. Weiblen replaces R. B. Randall, who is taking over the position of Pacific Coast manager for the Link Belt Company with headquarters in San Francisco.

Atlas Conveyor Company, Philadelphia, announces that A. J. Forschner has become associated with the company as vice-president. Mr. Forschner was formerly connected with the R. H. Beaumont Company as sales manager of the sand, gravel and stone department, and previously as president of the Alfred J. Forschner Company, distributor for Sauerman Bros.' power scrapers and slack line excavators. The Atlas Conveyor Company, in addition to its coal- and ash-handling equipment, will extend its activities to include the building of improved drag scrapers and slack line excavators.

Van Dorn Electric Tool Company, Cleveland, Ohio, announces that its sales branches in Los Angeles, San Francisco and Seattle, and its service branches in Los Angeles, Oakland and Seattle, have been supplemented by the establishment of a complete warehousing and service depot at Oakland, Calif.

Kohler Company, Kohler, Wis., reports that 120 of its unit electric light plants have been purchased by the U. S. Department of Commerce, 100 for beacons for the air mail routes and 20 for lighthouses. Each unit will be equipped with an automatic switch for the use of an astronomic timing device which will start the motor at sunset and stop it at sunrise.

New Developments

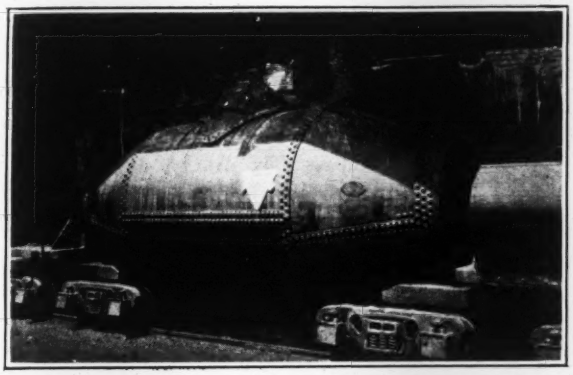
New Ladle Cars Transport Hot Metal 10 Miles

The plan recently inaugurated by the American Rolling Mill Company whereby it will transport hot metal from the blast furnaces of the Hamilton Iron & Coke Company in Hamilton, Ohio, to its mill at Middletown is noteworthy in several ways. In the first place, it will tend to stabilize the steel making industry in the Miami Valley. The transportation of hot metal for a distance of ten miles is unusual. The special cars required for this work are of unusual design, and the railroad construction necessary to the plan was both difficult and expensive.

The Hamilton furnace is located on the Toledo line of the Baltimore and Ohio Railroad, while the plant of the American Rolling Mill Company is reached by its Middletown branch. But for reasons of safety and speed, it was not practicable to use the present lines, making necessary the construction of a new connection about three miles long between the main line and the branch, the reconstruction of the branch and a new connection at the rolling mill. In addition to the danger of moving the molten metal over the high speed main line, the route over the tracks already existing would have allowed the metal to cool too much for manufacturing purposes. These disadvantages are avoided over the route provided by the new connection. The cost of the new road was approximately $1,500,000 and it was built in record time.

Three specially designed ladles double-lined with fire brick are used to carry the molten metal which can be held in the ladle 48 hours if necessary. The capacity of the ladles is 150 tons each.

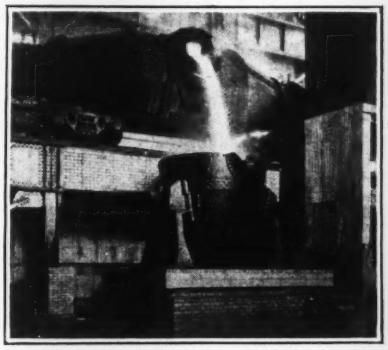
There are several places in the country where molten metal is transported from one plant to another, but these ladle cars are of a new and heavier type than any heretofore used. Their length is about 56 ft., and there are four axles



LADLE CAR USED TO TRANSPORT MOLTEN METAL

at each end. When loaded with molten iron, they weigh 340 tons. The ladle is mounted on pivots and tilting to discharge is accomplished by electricity. Only when the car is at a standstill can the electric attachment for tilting be made.

When the ladle car reaches the rolling mill plant, the metal is poured into



EMPTYING THE LADLE CAR

Metal has been transported 10 miles in the ladle car. The open top ladle into which it is being poured will be emptied directly into the open hearth furnaces.

a small open ladle from which it is poured directly into the open hearth furnaces.

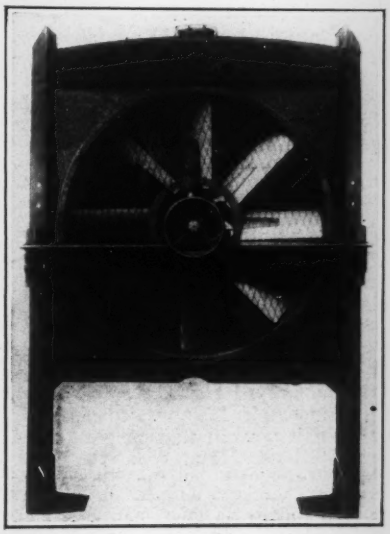
The present rate of production of the blast furnace is 550 tons every 24 hours. The Hamilton Coke & Iron Company is now owned jointly by the American Rolling Mill Company and the Koppers Company. A large new by-products plant has recently been installed for the manufacture of coke and the resultant by-products.

Pile Extractor

A pile puller or extractor which is operated either by steam or compressed air, and which is used only for the purpose of pulling steel sheet piles out of the ground, is being manufactured by the Vulcan Iron Works, Chicago, as a supplement to its pile driving equipment. From a crosshead at the top of the working cylinder are suspended two eyebars which extend below the cylinder and carry a bottom crosshead. From this crosshead in turn are suspended two bars or links which straddle the top of the pile and have holes for a bolt put through the bars and the pile. The only moving part is the ram, no steam valve being used. In operation, the extractor is hung from a crane or derrick which exerts a pull of 10 to 15 tons, or not more than 35 tons, while the ram strikes 550 blows per minute against the top crosshead. This machine is made in two sizes, weighing 1,200 and 2,400 lb. and having a 200-lb. or 400-lb. ram respectively. The pressure of steam or air may be from 75 to 150 lb.

Radiator-Fan Unit for Motors

A new type of radiator for Diesel and heavy-duty gas engines has just been announced by the Perfex Corporation, Milwaukee, Wis. Sizes from 50 to 350 hp. are now available. The new feature is the mounting of an unusually large air-circulating fan directly on the radiator frame. This is completely protected by a screen and shrouded to insure uniform air circulation over the entire radiator. The fan is carried on anti-friction bearings and is provided with a large enough belt pulley to insure positive fan operation over long periods without attention. The radiators incorporate the latest developments in removable core sections, a feature which permits removal and repair of any individual section without dismantling, and also allows continued operation of the power plant for reasonable periods while a section is out. Each unit is securely held in place by four nuts.



The cores are made from copper to prevent corrosion. The tubes are oval in shape and have double lock seams that make them burst-proof when frozen. Copper heat-radiating fins, strengthened by hemmed front and rear edges, furnish a most efficient design of cooling unit. These fins are baked onto the tubes in ovens that have automatic temperature control in order to insure uniformity of product.

Manufacturers and Trade Associations

Calendar

Annual Meetings

TRACK SUPPLY ASSOCIATION, Chicago; annual exhibition and convention, Detroit, Sept. 18-20, 1928.

CONCRETE REINFORCING STEEL INSTITUTE, Chicago; semi-annual meeting, Buckwood Inn, Shawnee-on-Delaware, Pa., October 1-3, 1928.

New Publications

Portable Belt Conveyors—GEORGE HAISS MFG. COMPANY, INC., New York City, has devoted a new catalog No. 1127 to its portable belt conveyors. Models for various uses are illustrated and described, and in addition tables giving standard sizes and general specifications are included. Much space is given to the structural makeup of the conveyors with special regard to the use of ball bearings. Many typical illustration photographs are shown and in the back of the catalog are given a number of material-handling layouts in which the portable belt conveyor is the key machine.

Traffic Signals—CROUSE-HINDS COMPANY, Syracuse, N. Y., devotes its bulletin 2110 to isolated traffic signals. Illustrations are given of the various types of signals for differently arranged intersections. The signals are furnished for either 110- or 220-volt a.c. or d.c.

Incinerators—PITTSBURGH-DES MOINES STEEL COMPANY, Pittsburgh, Pa., has published a 23-page catalog describing its "United States Standard" incinerator system and a number of installations where these have been in use. The design, construction and operation of the incinerator is each considered in detail.

Roof Purlins — MACOMBER STEEL COMPANY, Canton, Ohio, has published a folder describing its Massillon roof purlins in which are given safe-load tables, standard specifications and design data to be used by the engineer in determining the size of purlins necessary. Details of the purlins are given in adition to a list of general specifications and tables of dimensions.

Business Side of Construction

Facts and Events That Affect Cost and Volume

Heavy Road and Building Lettings Boost Volume

The two accompanying tables show the value of private contract awards to be 22 per cent greater than for the first half of 1927 and public awards 10 per cent greater, the principal reason being heavy lettings of road and building contracts. Value of road contracts already reach $332,500,000, compared with $243,000,000 in the first half of 1927. Both industrial buildings and commercial and institutional buildings are 25 per cent ahead of last year's values. There has been a falling off in water-works, sewers, excavation and drainage, and unclassified jobs. At the present rate the total engineering construction contracts for the whole of 1928 will exceed last year's total by a quarter of a million dollars.

Contract values in the region between the Mississippi River and the Rocky Mountains are about the same as those of last year. There has been a 7 per cent decline in the Far West. All other regions show increases, the greatest being in the Middle Atlantic States and the South.

CONTRACTS AWARDED BY CLASSES

(Entire U. S.)	First Six Months (Millions of Dollars) 1928	1927	Per Cent Gain (+) or Loss (—) in 1928
Water-works	28.8	30.8	— 6
Sewers	51.4	55.1	— 6
Bridges	68.9	66.0	+ 4
Excavations	15.3	29.6	—48
Streets and roads	332.5	243.0	+37
Industrial buildings	146.3	117.2	+25
Commercial buildings	968.7	777.7	+24
Federal government	24.8	22.7	+ 9
Unclassified	137.1	172.9	—22
Total private	1,108.5	910.8	+22
Total public	665.5	604.1	+10

CONTRACTS AWARDED BY SECTIONS

	First Six Months (Millions of Dollars) 1928	1927	Per Cent Gain (+) or Loss (—) in 1928
New England	121.8	120.1	+ 1
Middle Atlantic	643.6	463.1	+39
South	127.3	103.5	+23
Middle West	448.1	379.1	+18
West of Mississippi	265.3	268.7	— 1
Far West	167.9	180.6	— 7
United States	1,774.0	1,515.0	+17

June Contrcts

Heavy construction contracts, reported by *Engineering News-Record* in the week ended June 28, with some comparisons, total as follows:

(In Thousands of Dollars, 000 Omitted)

Week Ended	Public	Private	Total
June 26, 1928	**45,215**	**80,536**	**125,751**
June 19, 1928	28,738	28,743	57,481
June 28, 1927	23,322	50,344	73,666
Jan. 1 to July 1: 1928	665,721	1,080,265	1,745,986
1927	604,130	910,849	1,514,979

E. N.-R. Index Numbers

Cost			Volume		
July 1,	**1928**	**206.65**	**June,**	**1928**	**308**
May 1,	1928	207.00	April,	1928	316
June 1,	1927	205.55	May,	1927	299
Average,	1927	206.24	Average,	1927	263
Average,	1926	208.03	Average,	1926	228
1913		100.00	1913		100

State and Municipal Financing Down in June

May and June are normally the periods of the heaviest borrowing by states and cities through the issuance of long-term bonds. This year, reports *The Daily Bond Buyer*, the volume of new issues showed a substantial decline in comparison with the corresponding months of 1927. In that year the two months' total was $374,000,000, as against $272,000,000 this year. This contraction is reflected in the half-yearly totals given in the table. The current year's total for June is the smallest since 1920.

	June 30	6 Months Ending June 30
1928	$125,287,000	$771,242,022
1927	164,298,662	838,582,473
1926	145,616,332	743,313,662
1925	144,688,715	749,907,851
1924	286,507,401	830,770,457

New state and municipal bond issues approved during the month of June totaled $45,609,845, as compared with $73,815,000 during the same month in 1927, and $39,174,119 during May, 1926. This total embraces the financing operations of 201 municipalities located in 36 states.

During the same period bonding propositions aggregating $35,816,670 were defeated by the taxpayers of 58 municipalities in 18 states. The figure for June, 1927, was $58,478,758, compared with $19,845,260 for June, 1926.

Among the larger issues approved were St. Louis County, Mo., $10,000,000; Houston, Tex., School District, $4,000,000; Hidalgo County, Tex., $2,500,000; Tipton County, Tenn.; Tarramt County, Tex., $4,920,000.

Manufacturing Employment Same as in May

Employment and pay-roll totals in manufacturing industries were little changed in May, 1928, compared with April, 1928, employment being 0.2 per cent lower and pay-roll totals 0.2 per cent higher.

The downward trend of employment, which is usual in May, was considerably less than it was in that month of the years 1924-1927, and even the small decrease reported by the Bureau of Labor Statistics is practically all due to a strike in a single cotton goods mill.

How Business Is

Despite the holiday, volume of contracts and of materials production remain at high levels. Steel output this month, usually the lowest of the year, is expected to be at 70 per cent capacity. The average rate for the half year was 84 per cent. Business is particularly brisk in line pipe orders (200,000 tons in the last three weeks), and structural steel orders to date are definitely ahead of other years. In the Youngstown district 115 of 127 sheet mills are in operation. Tin plate mills are operating at capacity. Of 53 independent open-hearth furnaces, 37 are active.

Lumber movement during the week ended June 30 continued at the high level established earlier in the year, according to the National Lumber Manufacturers Association. Relation between supply and demand in the first half is stated to have been more satisfactory than at any time during the last five years, and "the trade appears to be sanguine regarding the latter half."

Production and sales of motor cars, particularly the lower-priced cars, continue well above those of this time last year. "Profits have been strengthened," says *Automotive Industries*, "by the large volume of business, by slightly lower prices of some important raw materials and by the firm maintenance of the price structure."

Wholesale commodity prices continue to rise, as mentioned here last week. The *Annalist* index for July 2 is 151.1, compared with 150.1 for June 26 and 148.9 for June 19. The increase is in farm products, textiles and fuels. There are no changes reported for the metals, foods, chemicals or building materials.

The long-term Treasury bond issue has had the effect of strengthening prices in the bond market, investors regarding it as an evidence of confidence in the money and security markets. The feeling was further increased by the decline in call and time money rates. Holders of Third Liberty 4½s, which mature Sept. 15, 1928, may exchange them for the new Treasury 3⅜ per cent 15-year bonds. The present market price of Third Libertys is $1 above the $100 redemption price.

Manhattan's Building Operations 47 Per Cent Above 1927

Building plans filed in the Borough of Manhattan since Jan. 1 total 671 worth $199,440,880, compared with 448 worth $135,172,455 in the first half of 1927. Thus, average building operations for the two years cost $297,000 and $302,000, respectively.

This year's plans include 143 tenements averaging $420,000, thirty store and loft buildings averaging $215,000, and 39 offices averaging $1,315,000. There are 23 factories ($654,000), compared with 24 ($470,000) last year.

During June plans were filed for 59 buildings costing a total of $35,362,675, against 49 costing $28,991,305 in June, 1927.